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ABSTRACT

This guide describes the requirements for courses in computer-aided design and computer-aided manufacturing (CAD/CAM) that are part of engineering technology programs conducted in vocational-technical schools in Georgia. The guide is organized in five sections. The first section provides a rationale for occupations in design and in production, traces the origin of courses in design and production techniques, and lists occupational competencies for CAD/CAM occupations. In the second section, course objectives and scheduling outlines for programs are presented, while the third section suggests a course structure. The fourth section is a guide to the modules to be taught in the CAD/CAM courses. The final section contains references to instructional materials and equipment, occupational inventory and occupational competencies checklists, job descriptions for engineering and science technology, and a glossary of occupational terms. (KC)

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ENGINEERING TECHNOLOGY PROGRAMS

COURSES GUIDE

FOR

COMPUTER AIDED DESIGN

AND

COMPUTER AIDED MANUFACTURING

DEVELOPED UNDER AGREEMENT WITH

DIVISION OF PROGRAM DEVELOPMENT
OFFICE OF VOCATIONAL EDUCATION
GEORGIA DEPARTMENT OF EDUCATION
ATLANTA, GEORGIA 30334

CHARLES McDANIEL, STATE SUPERINTENDENT OF SCHOOLS

AUGUST 1983

CE 039995

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ENGINEERING TECHNOLOGY

Developed and Produced
Under Contractual Agreement with

Division of Program Development
Office of Vocational Education
Georgia Department of Education
Atlanta, Georgia 30334
Charles McDaniel, State Superintendent of Schools
1983

CAD/CAM COURSES GUIDE

Developed By

The University of Georgia

Vocational Education Materials Center

Division of Vocational Education

College of Education

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PREFACE

The preface of the Preliminary Curriculum Planning Guide, August 1983, begins:

"The term 'high technology' has been used in recent years to describe and refer to the most advanced devices, processes and machinery in the modern world. High technology holds the promise to our state's future growth and productivity; it also demands new skills and a broader knowledge base for our future technical workforce.

Georgia is responding to this workforce demand by encouraging its area technical schools to undertake revolutionary changes in curricula to prepare engineering technicians."

This CAD/CAM Courses Guide brings us another step closer to our goal of defining the curriculum guidelines for two year programs in Engineering Technology. The material presented here will provide the base information for developing locally tailored instructional programs in these newly formed and rapidly expanding technical occupations.

William P. Johnson
Associate State Superintendent
of Schools

ACKNOWLEDGEMENT

Responsibility for planning this effort has been under the direction of Dr. James M. Conkwright, Director, Program Development and Support Services, Dr. Jerry D. Roseberry, Director, Program Improvement and Evaluation, and Ms. Patt Stonehouse, Curriculum Development Consultant. Others assisting on this project were Mr. Robert K. Mabry, Director, Post Secondary Instructional Programs and Mr. Russell L. Meade, Coordinator for Technical and Related Instruction.

The developer's review of current programs was aided by input from:

Athens Tech	Moultrie Tech
Augusta Tech	North Georgia Tech
Brunswick Junior College	Pickens Tech
Columbus Tech	Savannah Tech
Dalton Junior College	Thomas Tech
DeKalb Community College	Walker Tech

Curriculum coordination was provided by Dr. Kenneth R. Aller and Mr. J. D. Fowler, Georgia State University Vocational and Career Development Department, Dr. Harmon R. Fowler, Chairman.

Technical expertise for CAD/CAM Systems and supporting programs was provided by: Mr. Dennis Luber, Computervision, Atlanta; Mr. Donald J. Rogers, Mr. Dugar Strickland, and Mr. Joe M. Wood, Lanier Tech; Mr. Michael W. Offik, CAD/CAM Manager, Reliance Electric, Athens; and, Mr. Kenneth S. Shain, Shain Associates, Atlanta.

CONTENTS

	Page
Preface	iii
Acknowledgements	iv
Section I - Rationale for Occupations (Yellow)	
Occupations in Design	3
Occupations in Production	4
Origin of Courses	6
CAD Occupational Competencies	9
CAM Occupational Competencies	14
Section II - Curriculum Parameters (Green)	
The Need for "BASICS"	19
Course Objectives - Introduction to CAD	20
Course Objectives - CAD Applications	21
Course Objectives - Computer Aided Manufacturing	22
Course Objectives - CAD/CAM Problems	23
Scheduling Outline for Programs in Design Technology	25
Scheduling Outline for Programs in Production Technology	27
Section III - Suggested Course Structure (Blue)	
Establishing Course Objectives	31
Introduction to Computer Aided Design	32
CAD Applications	33
Computer Aided Manufacturing	33
CAD/CAM Problems	34
Guidelines for Student Prepared Technical Reports	36
Section IV - Modules Guides (Gold)	
Format for Module Guides	47
Modules: Introduction to Computer Aided Design	49
Modules: CAD Applications	79
Modules: Computer Aided Manufacturing	109
Modules: CAD/CAM Problems	139

CONTENTS (Continued)

Section V - References (Pink)

Instructional Material..... 171
Equipment Lists..... 179
CAD/CAM Occupational Inventory Checklist..... 185
CAD Occupational Competencies Checklist..... 197
CAM Occupational Competencies Checklist..... 203
Job Description for Engineering and Science Technology..... 207
Glossary of Occupational Terms..... 215

SECTION I

Occupations in Design:

Graduates of the design option will be prepared at the entry level as: drafting technician; engineering assistant; research technician; or developmental laboratory technician. Competency in drafting and design is developed by the drafting experience gained through completing the following five courses:

Title

Engineering Graphics

Advanced Engineering Graphics

Introduction to Computer Aided Design

Computer Aided Design Applications

CAD/CAM Problems

Additionally, courses in mechanical devices and systems, manufacturing processes, statistics and dynamics, electromechanical devices, strength of materials, engineering materials, fluid power, and machine design provide breadth at understanding the engineering fields needed for effective engineer-technician communications. The whole of the program integrates mathematics, science and technical courses in a competency-based program which builds measurable skills for occupations in the design field.

Occupations in Production:

Graduates of the production option will be prepared for entry into occupations with a wide range of titles:

Assembly technician
Cost analysis technician
Cost estimator
Cost control technician
Industrial technician
Instrument maintenance technician
Job methods technician
Machine-load-control planner
Materials control technician
Metallurgical technician
Methods analyst
Motion-and time-study analyst
Plant layout technician
Plant maintenance technician
Process description writer
Production control supervisor
Production estimator
Production expediter
Production planner
Production technician (specialty in specific industry)
Quality control technician
Safety inspector
Specifications writer
Tool planner
Tool-project coordinator
Precision inspector

Competency in production technology is developed by experienced gained through completing the following five courses:

Title
Manufacturing Processes I
Instrumentation and Control
Manufacturing Processes II
Computer Aided Manufacturing
CAD/CAM problems

Additionally, courses in engineering graphics, mechanical devices and systems, statistics and dynamics, strengths of materials, engineering materials, computer aided manufacturing, fluid power, and machine design provide breadth at understanding the need for effective engineeringtechnician communications. As in the design option, the whole of the program integrates mathematics, science and technical courses into a competency-based program which builds measurable production skills.

Origin of Courses

The structure of educational programs for design and production techniques has been relatively unchanged during the past two decades. Figures 1 and 2 are suggested programs for these two diciplines which were presented in 1962.

Design Major

(72 credit hours)

First Year

Course No.	Course title	Class hours	Laboratory hours	Total hours	Credit hours
First term		**16**	**9**	**25**	**18**
G 100	Orientation	1	0	1	0
DP 103	Materials of Industry	3	0	3	3
DP 104	Mechanical Drafting I	2	6	8	4
DP 113	Manufacturing Processes I	2	3	5	3
M 115	Mathematics I	5	0	5	5
G 123	Communication Skills	3	0	3	3
Second term		**14**	**11**	**25**	**18**
A 132	Technical Reporting	2	0	2	2
DP 133	Manufacturing Processes II	2	3	5	3
DP 134	Mechanical Drafting II	2	6	8	4
M 144	Mathematics II	4	0	4	4
S 145	Mechanics and Heat	4	2	6	5

Second Year

Third term		**12**	**15**	**27**	**18**
A 204	Strength of Materials	3	2	5	4
D 205	Basic Mechanisms	2	9	11	5
S 214	Electricity	3	2	5	4
G 222	American Institutions	2	0	2	2
S 223	Hydraulics and Pneumatics	2	2	4	3
Fourth term		**11**	**15**	**26**	**18**
D 233	Machine Design	3	0	3	3
D 234	Basic Tool Design	1	6	7	4
D 235	Design Problems	1	9	10	5
G 283	Psychology and Human Relations	3	0	3	3
A 293	Industrial Organizations and Institutions	3	0	3	3

A—Auxiliary or supporting technical courses
D—Specialized courses (Design major)
DP—Specialized courses common to both design and production majors
G—General courses
M—Mathematics courses
S—Science courses

Figure 1 (OE-80019, page 4)

OE-80019 U.S. Office of Education, Mechanical Technology Design and Production: A Suggested 2-Year Post High School Curriculum. Washington, DC: GPO, 1962

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Production Major

(70 credit hours)

First Year

Course No.	Course title	Class hours	Laboratory hours	Total hours	Credit hours
First term		**16**	**9**	**25**	**18**
G 100	Orientation	1	0	1	0
DP 103	Materials of Industry	3	0	3	3
DP 104	Mechanical Drafting I	2	6	8	4
DP 113	Manufacturing Processes I	2	3	5	3
M 115	Mathematics I	5	0	5	5
G 123	Communication Skills	3	0	3	3
Second term		**14**	**13**	**27**	**18**
A 132	Technical Reporting	2	0	2	2
DP 133	Manufacturing Processes II	2	3	5	3
DP 134	Mechanical Drafting II	2	6	8	4
M 144	Mathematics II	4	0	4	4
S 145	Mechanics and Heat	4	2	6	5

Second Year

Third term		**12**	**9**	**21**	**16**
P 204	Methods and Operations Analysis	3	3	6	4
A 213	Statistics and Quality Control	2	2	4	3
S 214	Electricity	3	2	5	4
G 222	American Institutions	2	0	2	2
S 223	Hydraulics and Pneumatics	2	2	4	3
Fourth term		**13**	**15**	**28**	**18**
P 234	Plant Layout and Material Handling	3	3	6	4
P 244	Process Planning	3	3	6	4
P 254	Production Problems	1	9	10	4
G 283	Psychology and Human Relations	3	0	3	3
A 293	Industrial Organizations and Institutions	3	0	3	3

A—Auxiliary or supporting technical courses
DP—Specialized courses common to both design and production majors
G—General courses
M—Mathematics courses
P—Specialized courses (Production major)
S—Science courses

Figure 2 (OE-80019, page 5)

Upon review, one quickly noticed that many of these same courses are in existence today. However, today the tools of these occupations are centered more and more on processes which are computer controlled. Technicians are used along every phase of a product's life. (see Figure 3) If one of the tools being considered is the computer, then it becomes apparent that this tool has application in all phases of a product's life.

OE-80019 U.S. Office of Education, Mechanical Technology Design and Production: A Suggested 2-Year Post High School Curriculum. Washington, DC: GPO, 1962

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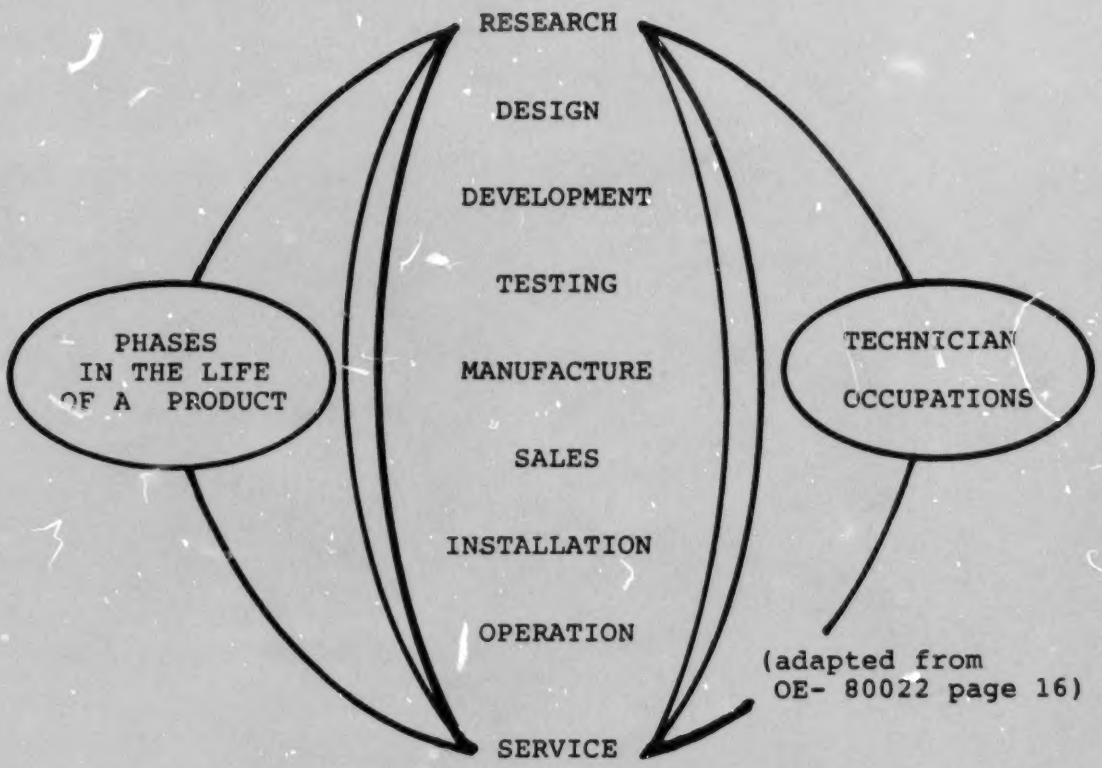

Figure 3 - Technician occupations in the life of a product

Therefore, courses in the design and production curriculum must present the foundation, knowledge and skills; e.g., the standards for materials and the materials condition test using instruments. Also, the courses require the development of the computer skills which, when employed, will increase capacity and decrease production time.

This courses guide retains those "basics" which the technician must master in order to be considered competent and also offers the opportunity to build the entry level skills which apply directly to the design and production areas.

OE-80022 U.S. Office of Education, Education For A Changing World of Work: Appendix I, Technical Training In The United States. Washington, DC: GPO, 1963

CAD OCCUPATIONAL COMPETENCIES

A. Competent in terminology and description of the purpose of:

1. categories of CAD equipment
2. the CAD program language
3. CAD storage systems
4. the CAD system function board
5. the CAD system process memory
6. the CAD system graphics tablet
7. the CAD system pen plotter
8. the computer aided manufacturing by numerical control
9. the computer aided manufacturing by robotics
10. CAD basic commands and functions
11. purpose of the display file
12. three-dimensional viewing
13. INPUT techniques
14. system transformations
15. software graphic and nongraphic data base

16. major hardware components of a graphics production systems

17. recording devices

18. display devices

19. work station input devices

B. Competent in describing:

1. the advantages of a CAD method when compared with manual instrument method

2. the disadvantages of a CAD method when compared with manual instrument method

3. CAD system start up procedures

4. CAD system point positioning procedures

5. CAD system function board

6. the method of digitizing the CAD system

7. the purpose of the CAD system light pen

8. generating a line with a CAD system

9. the procedure for generating a circle using the CAD system

10. the CAD system procedure for generating an irregular curve or spline

11. the CAD system procedure for generating dimension notations

12. the CAD system procedure for generating text for graphics

13. the CAD system procedure for generating graphic changes by geometry modifiers

14. the fields in which computer graphics have application in the overall range of occupations

15. major hardware components of a graphics production system

16. the purpose of recording devices

17. the purpose of display devices

18. the purpose of work station input devices

C. Competent in demonstrating the operational skills associated with:

1. CAD system start up

2. CAD system point positioning

3. using the CAD system function board

4. digitizing the CAD system

5. line generation using the CAD system

6. generating a circle using the CAD system

7. generating an irregular curve or spline

8. CAD system generation of dimension notations

9. CAD system generation of text for graphics

CAD OCCUPATIONAL COMPETENCIES

10. CAD system generation of graphic changes by geometry modifiers

11. CAD system mechanical drawing using a function board

12. CAD system generation at a schematic diagram using a function board

13. CAD system mechanical drawing using a graphics tablet

14. CAD system production at a piping diagram using a graphics tablet

15. CAD system production of a mechanical drawing using a light pen

16. CAD system symbol development using a joystick

17. CAD system graphics editing by ERASE modifier

18. CAD system graphics editing by the DELETE modifier

19. CAD system graphics editing by the REDRAW function

20. CAD system graphics editing by the SHIFT, OFFSET or REPOSITION procedure

21. CAD system graphics editing by the SCALE or SIZE function

22. the CAD system method of storing or filing documents

23. the CAD system method of establishing a library of files

24. using the CAD system to do sectioning

25. using the CAD system to rotate graphics

CAD OCCUPATIONAL COMPETENCIES

26. using the CAD system to generate a three-dimensional drawing

27. using the CAD system to generate a bill of materials

28. three-dimensional viewing

29. system transformations

30. INPUT techniques

31. kinematics graphics

C A M O C C U P A T I O N A L C O M P E T E N C I E S

A. Competency in terminology and description of the purpose of computer aided manufacturing (CAM):

1. catagories of equipment
2. program language
3. data storage security system
4. INPUT techniques
5. system transformations
6. process monitoring devices
7. work station data input and function controls
8. processes and procedures

B. Competency in describing:

1. the advantages of a CAM system in comparison with conventional manufacturing procedures and processes
2. the advantages of a conventional manufacturing system when compared with a CAM system

C. Competency in demonstrating the operational skills associated with:

1. making computer application analysis for CAM systems
2. writing a basic CAM system program
3. selecting CAM software

CAM OCCUPATIONAL COMPETENCIES

4. modifying CAM system software

5. scheduling job orders

6. requisitioning materials

7. flow charting production assembly lines

8. protection and control of production resources

9. planning and scheduling the assembly of components into a product

10. planning and scheduling packaging

11. planning and scheduling shipping of product

12. developing and writing production reports

13. making oral reports

14. analysis of time and motion

15. conducting a cost analysis

16. analysis of production methods and processes

17. developing job status reports

18. writing technical reports

19. developing informational charts, diagrams and graphs

20. advising on "make or buy" decisions

21. developing sources of supply

CAM OCCUPATIONAL COMPETENCIES

22. obtaining bids and quotations

23. selecting vendors

24. issuing purchase requests

25. receiving and inspecting incoming materials

26. planning, scheduling and distributing materials to production area

27. developing engineering change notices and rejection reports

28. writing change notices and modification recommendations

29. developing and conducting quality control procedures

30. analysis of varying environmental conditions

31. Numerical Control (NC) systems

32. Computer Numerical Control (CNC) systems

33. Direct Numerical Control (DNC) systems

34. Integrated design and manufacturing computer-based programs

SECTION II

The need for the "basics":

Technical occupations have certain unique requirements that influence the content and organization of the curriculum. Some of these requirements are imposed by the organizational functions that graduates must be prepared to perform; some result from the need for special courses that will maximize the effectiveness of teachers who have special competencies; and others arise because of the need to teach both technical principles and industrial applications in the limited time available. For example, technology curriculums reflect three basic requirements: functional utility, units of instruction in specialized technical subjects, and provision for the teaching of principles by application. In addition, the curriculum includes general education values which are essential in today's dynamic social order.

Field functional competence has at least three components which are basic to program structure:

1. Prepare the graduate for productive employment at the entry level,
2. Provide a broad base in skills needed to advance in the field, and
3. Stress the field requirements to continue study in order to remain current.

COURSE OBJECTIVES

Introduction to Computer Aided Design

In the title, the term introduction implies that more study must be undertaken after completing this course if competency at the entry level into the occupation is to be gained. However, the mastering of the course objectives present at the introductory level will be accepted for entry into some beginning level positions. The objectives which follow are grouped to continue the students movement toward field functional competence.

1. Competency in recalling computer aided design system terminology.
2. Competency in recalling computer aided manufacturing system terminology.
3. Competency in activation and shutdown procedures for computer aided design systems.
4. Competency in running a computer aided design program.
5. Competency in CAD system circle construction.
6. Competency in CAD system construction at a spline.
7. Competency in drawing dimensional lines and inserting descriptive symbols.
8. Competency in using geometry modifiers to offer drawings.
9. Competency in using the function board to produce a mechanical drawing.
10. Competency in using the function board to produce a schematic diagram.
11. Competency in using the graphics table to produce mechanical and piping diagrams.
12. Competency in using the light pen to produce a mechanical drawing.
13. Competency in using a joystick to develop symbols.
14. Competency in methods of modifying existing drawing data.
15. Competency in methods of preserving computer data used for producing drawings.

COURSE OBJECTIVES

Computer Aided Design Application

This course provides the student with the opportunity to gain proficiency in a wide range of CAD system drawing capabilities. Completion of the modules in this series equips the graduate to become the design member of the CAD/CAM Problems Course team.

1. Competency of CAD system operation at the "Introductory" level.
2. Competency of using the CAD system to section drawings.
3. Competency in using the CAD system to create auxiliary views.
4. Competency in using the CAD system rotate command to reposition object(s).
5. Competency in producing three dimensional object drawing.
6. Competency in using special modification features of the CAD system.
7. Competency using the CAD system to produce a bill of materials.
8. Competency in using the CAD system to produce a two dimensional drawing.
9. Competency in using the CAD system to produce a three dimensional drawing.
10. Competency in using the CAD system to produce a two dimensional piping diagram.
11. Competency in using the CAD system to produce commercial building and civil drawings.
12. Competency in using the CAD system to produce an electronic assembly component parts layout drawing.
13. Competency in using the CAD system to produce schematic diagrams.
14. Competency in using the CAD system to produce multiple-plate two dimensional drawings of a CAM process product.
15. Competency in using the CAD system to produce multiple-plate three dimensional drawings of a CAM process product.

COURSE OBJECTIVES

Computer Aided Manufacturing

To many persons, the meaning of this term is limited to describing computer control of machines used for manufacturing a product. To an increasing number of engineers and managers, the term is taking on a meaning which encompasses computer-aiding of any activity within the manufacturing process; e.g., bills of materials, producing scheduling, and forecasting are examples in addition to the actual product producing machinery.

The competencies which follow are linked to this latter meaning of CAM and will equip the graduate with a range of experiences in keeping with developing trends in the high technology industries.

1. Competency in recalling computer aided manufacturing process terminology.
2. Competency in recalling procedural steps involved in generating a bill of materials.
3. Competency in recalling data requirements for computer-aided manufacturing.
4. Competency in the working of material requirements planning procedures.
5. Competency in developing a draft of the production planning process.
6. Competency in generating a master production schedule.
7. Competency in generating capacity planning reports.
8. Competency in outlining shop for control requirements.
9. Competency in preparing purchase order reports.
10. Competency in preparing data collection procedures for production forecasting.
11. Competency in recalling computer aided manufacturing software selection criteria.
12. Competency in preparing parts codes for a CAD/CAM interfaced process.
13. Competency in selecting computer aided manufacturing applications to meet specific production requirements.
14. Competency in selecting, modifying and verifying computer aided manufacturing software.
15. Competency in manufacturing a product using the computer aided manufacturing system.

COURSE OBJECTIVES

CAD/CAM Problems

In Analysis of Occupational Supply and Demand in Georgia (1), there is a comment which reflects the current industry trend.

Manufacturing

> The 1970's saw a shift in the concentration of workers within the major industry divisions in Georgia. Prior to that time, the manufacturing sector was the largest single source of jobs in the state. By 1974, however, manufacturing had been replaced by the service industries as the number one employer. Although manufacturing industries are expected to gain some 78,300 workers between 1976 and 1982, their percent of total state employment will continue to decline. This is due, in part, to an increase in usage of automated or semi-automated production machinery which reduces labor requirements. However, as can be seen in Table 1, there will continue to be a considerable degree of divergence among the individual manufacturing industries.
>
> Growth or decline will depend upon the interplay of such diverse factors as improvements in technology, limitations imposed by energy demands, and the effects of foreign competition on U.S. manufacturers (page 17).

For Georgia manufacturers to succeed in the world market, their processes must be cost effective. The role of CAD/CAM technicians is to assist engineers and managers in solving production problems, thereby, maintaining a competitive position for their firm.

The course competencies on the following page deal with solving the problems associated with increased use of automated and semi-automated manufacturing processes by major sectors of industry. Some of these competencies may

---

(1) Georgia Department of Labor, Analysis of Occupational Supply and Demand in Georgia. Atlanta, GA: Employment Security Agency, 1980.

be dealt with in other courses; e.g., competencies 2 through 5 could be placed in the manufacturing processes courses. Additionally, it is not practical to include all of the competencies 9 through 15 at every location. Each locally operated course will utilize competencies which reflects those of the region's industries.

1. Competency in the design and manufacturing requirements involving automatic measurement of a product specification.
2. Competency in the design and manufacturing requirements involved in foundry processes.
3. Competency in the design and manufacturing requirements involved in hot-forming metal.
4. Competency in the design and manufacturing requirements involved in cold-forming metal.
5. Competency in the design and manufacturing requirements involved in shaping metal with machine tools and turning machines.
6. Competency in the design and manufacturing requirements involved in producing cylindrical holes in metal with computer controlled drilling machine.
7. Competency in the design and manufacturing requirements involved in shaping and planning metal with a computer controlled shaper machine.
8. Competency in the design and manufacturing requirements involved in milling metal with a computer controlled milling machine.
9. Competency in the design and manufacturing requirements involved in producing plastic products with computer controlled processes.
10. Competency in the design and manufacturing requirements involved in producing electrical/electronic parts and assemblies with computer controlled processes.
11. Competency in the design and manufacturing requirements involved in packaging food with computer controlled processes.
12. Competency in the design and manufacturing requirements involved in producing electric motors/generators with computer controlled processes.
13. Competency in the design and manufacturing requirements involved in producing shoes and leatherworks with computer controlled processes.
14. Competency in the design and manufacturing requirements involved in producing textile produced with computer controlled processes.
15. Competency in the design and manufacturing requirements involved in producing wood and wood-based products with computer controlled processes.

MECHANICAL ENGINEERING TECHNOLOGY - DESIGN
STANDARD CURRICULUM - QUARTER SYSTEM
(SUGGESTED SEQUENCE)

	Class	Lab	Contact Hours	Cr
First Quarter				
Fundamentals of Engineering Technology	1	3	4	2
Computer Fundamentals	3	6	9	5
Algebra	5	0	5	5
English and Composition	5	0	5	5
	14	9	23	17
Second Quarter				
*Physics I	3	6	9	5
Trigonometry	5	0	5	5
Fundamentals of Electricity and Electronics (DC)	4	3	7	5
Engineering Graphics	1	6	7	3
	13	15	28	18
Third Quarter				
Graphics II	1	6	7	3
*Physics II	3	6	9	5
Analytic Geometry and Calculus	5	0	5	5
Fundamentals of Electricity and Electronics (AC)	4	3	7	5
	13	15	28	18
Fourth Quarter				
Statics & Dynamics	4	3	7	5
Introduction to CAD	1	6	7	3
*Physics III	3	6	9	5
Technical Writing	5	0	5	5
	13	15	28	18
Fifth Quarter				
Electromechanical Devices	4	3	7	5
Strength of Materials	4	3	7	5
CAD II (Application)	1	6	7	3
Mechanical Devices & Systems	5	0	5	5
	14	12	26	18
Sixth Quarter				
MFC Processes I	1	6	7	3
Engineering Materials	3	4	7	5
Computer Aided MFG (CNC)	1	6	7	3
Machine Design	4	3	7	5
	9	19	28	16

	Class	Lab	Contact Hours	Cr
Seventh Quarter				
Industrial Relations	5	0	5	5
Fluid Power	3	4	7	5
Economics	5	0	5	5
CAD/CAM Problems	0	9	9	3
	13	13	26	18

*Pilot Physics Program
7 Hours Contact Minimum
9 Hours Contact Maximum
5 Hours Credit

MECHANICAL ENGINEERING TECHNOLOGY - PRODUCTION
STANDARD CURRICULUM - QUARTER SYSTEM
(SUGGESTED SEQUENCE)

	Class	Lab	Contact Hours	Cr
First Quarter				
Fundamentals of Engineering Technology	1	3	4	2
Computer Fundamentals	3	6	9	5
Algebra	5	0	5	5
English and Composition	5	0	5	5
	14	9	23	17
Second Quarter				
*Physics I	3	6	9	5
Trigonometry	5	0	5	5
Fundamentals of Electricity and Electronics (DC)	4	3	7	5
Engineering Graphics	1	6	7	3
	13	15	28	18
Third Quarter				
Introduction to CAD	1	6	7	3
*Physics II	3	6	9	5
Analytic Geometry and Calculus	5	0	5	5
Fundamentals of Electricity and Electronics (AC)	4	3	7	3
	13	15	28	16
Fourth Quarter				
Statics and Dynamics	4	3	7	5
MFG Processes I	1	6	7	3
*Physics III	3	6	9	5
Technical Writing	5	0	5	5
	13	15	28	18
Fifth Quarter				
Electromechanical Devices	4	3	7	5
Strength of Materials	4	3	7	5
Economics	5	0	5	5
Mechanical Devices and Systems	1	6	7	3
	14	12	26	18
Sixth Quarter				
MFG Processes II	1	6	7	3
Engineering Materials	3	4	7	5
Computer Aided MFG (CNC)	1	6	7	3
Machine Design	4	3	7	5
	9	19	28	16

	Class	Lab	Contact Hours	Cr
Seventh Quarter				
Industrial Relations	5	0	5	5
Fluid Power	3	4	7	5
Elective	3	4	7	5
CAD/CAM Problems	0	9	9	3
	11	17	28	18

*Pilot Physics Program
7 Hours Contact Minimum
9 Hours Contact Maximum
5 Hours Credit

SECTION III

ESTABLISHING COURSE OBJECTIVES

Each of the four courses presented in this guide serve to build within each graduate those competencies which will insure success in an occupation requiring either design or production skills. While this guide takes an industry wide approach in presenting objectives, it is expected that each locally managed course will be designed to meet that particular community's needs.

A logical first step in outlining course objectives is to perform a needs analysis. In the references, Section V of this guide, are five tools useful in performing the needs assessment. These are:

1. CAD/CAM Occupational Inventory Checklist,
2. CAD Occupational Competencies Checklist,
3. CAM Occupational Competencies Checklist,
4. Job Description for Engineering and Science Technology, and
5. Glossary of Occuptional Terms.

These tools serve as aids to construct job descriptions reflective of regional occupations. Those descriptions are compared with the national, i.e. U. S. Labor Department's descriptions to assure that all terms used in the description follow accepted standard definitions.

The checklists are designed for conducting an interview of CAD/CAM managers. The interview technique of gathering data allows the instructor to visit the work setting and become personally acquainted with the firms, their operation, and their staff. The face-to-face contact may

also gain willingness to help in later requests for occupational information or an acceptance to serve on the CAD/CAM courses advisory committee.

If a needs assessment is to be conducted by way of a survey instrument, these checklists may be modified for that purpose.

Once the data from all local firms has been collected, the data analysis is undertaken with the goal of defining those occupational competencies which are appropriate to the educational process. The process used in this analysis is that of matching the identified occupational competencies with those course competencies which have a common or similar objective. For each course there are specific comparisons which should be stated.

The analysis defined competencies related directly to the content base for the education program. These competencies represent possible limits for the program while actual program content may, and probably will, be of less scope. Some competencies may be dealt with in other courses (see page 23, 24). Other competencies, although identified through the analysis process, may be performed so seldom that inclusion in an educational course is not justified.

For additional information on program structuring the reader is directed to the Research and Development Series No. 234 titled CAD/CAM Programs available from the National Center for Research in Vocational Education. Consult the resource addresses page 177 for the Center's address.

Introduction to Computer Aided Design

Initially, those occupational competencies which are aligned with the course competencies listed in Section II should be identified. For this guide, some course competencies will be a direct match, some may need modification and a few will require the rewriting the course competency statement. Whenever new course competencies are written, a decision must be made regarding which of the four courses is appropriate for its development. Only those which are clearly basic in nature should be included in the introductory course. There is a natural tendency to "teach the world" in the first course of any series of allied courses. If in doubt, include such a competency in the succeeding course or consider eliminating it as a course objective and identify it as a job setting training objective.

CAD Application

Local course objectives should as closely adhere to the occupational competencies of an application nature which local firms routinely perform. The applications course requires a great deal of software and, where possible, the programs run in this course should reflect those currently used in the field. Whenever firm and school have compatible CAD systems, it may be possible to obtain a copy of programs from the firm. If the material is copyrighted obtain a release and document this fact in the software package so that all program operators are aware of the source and any restriction of use.

Working files for the applications course may also be constructed from the products generated by completing the exercises undertaken in the introductory course. Proper selection is critical to the operation of a realistic course. Include only software programs which are directly related to occupational competencies.

Computer Aided Manufacturing

This course is also an "introductory" course. It presents the first opportunity for the production student to view the whole realm of manufacturing processes which are prospects for computer-aided operations. As with the first course in computer-aided design, the beginning point for defining course objectives is the identification of occupational competencies. The CAM OCCUPATIONAL COMPETENCIES, located in Section II, are generic to manufacturing processes and will be present in all firms, although, some may be subparts of a firm's stated occupational competency.

Selection of course competencies, like the process used for the Introduction to CAD course, is a matching process which links the individual course competency with the associated occupational competency. Again, some will be a direct fit, others may require adaptation, and some course competencies may be generated locally.

The major consideration for grouping course competencies remains that of constructing a range of student activities which relates to skills the graduate must have when employed. If in doubt, do not include the suspect topic in the course.

CAD/CAM Problems

A problems course has as its goal the building of a decision making ability. The CAD/CAM Problems course competencies, listed in Section II, should not be viewed as a total requirement list for a course. Rather, they are related competencies which reflect a wide range of manufacturing activities in Georgia. The actual course competencies selected for a locally operated program may be less than half those listed. Again, selection of course content must follow the related occupational competencies which have been defined as a result of a locally undertaken needs analysis.

Identification of each problem should be a student activity. The instructor would, of course, monitor the student's choice and be ready to state "That's no problem!" should the facts indicate. Also, the instructor must eliminate student identified problems beyond the scope of the course. Problem selection for each competency undertaken should meet the minimum requirement of:

1. Student selection,
2. Instructor concurrence, and
3. "Do-able" within the allowed time and CAD/CAM course support capability.

Proficiency in a problems course is usually evaluated by the instructor's rating of a student prepared technical report. Technical reports are often required by manufacturing firms. They are used to report what happened or what could happen. In both cases, the problem statement revolves around the general question "What is the status?" Following are guidelines for preparing these reports.

Guidelines for Student Prepared Technical Reports

Instructional materials should be prepared to supplement the use of textbooks and references. This is especially necessary in laboratory instruction where it is always advisable to organize the instruction around industrial applications of the principles being taught.

The sample instructional materials included have illustrated a way of expanding and supplementing the module of instruction outlined in the guide. The requirement for a student prepared technical report begins with the "Laboratory Assignment Sheet" (see page 37). Here the instructor presents to the student the information which established the expected performance while the student is conducting the research. It is very important that the student understands that evaluation of performance will be measured on the basis of quality reflected in the technical report. The marking of reports is of extreme importance in making this aspect of technical instruction effective. Unless this marking is done as carefully and objectively as possible, the student may be misled and actually misinformed. Marking should also include attention to form, style, clarity of expression, and spelling.

The Technical Report:

Much of the effectiveness of formal training rests upon the standards required in reporting. Employers stress the importance of communications, especially for the liaison type jobs so often assigned to the technician. Perhaps the most thorough approach to this in the instructional program

(SAMPLE)

LABORATORY ASSIGNMENT SHEET

Module No: XX (title) _____

_____

References:

Author, Title _____

Objectives:

Module Performance Statement

Procedures:

From: Module Job Sheet, Exercise, or Experimental Guide Sheet

Questions:

From: Module, Job Sheet, Exercise, or Experimental Guide Sheet

is found in the formal and informal reporting of laboratory work. This includes not only the basic "experiment" laboratory project, but also design problems, research studies, and field study of industrial installations.

The form and style of the formal report should be established early in the program in order to attain a degree of uniformity. The report standards included here are intended for the student's orientation. The standards follow accepted patterns of reporting. A common deficiency in student work is insufficient attention to detail. The guide used should direct attention to the importance of detail as well as logical conclusion in the reporting process.

General Characteristics:

Laboratory experiences are usually summarized in the form of reports. In most cases the reports are submitted to those who have not been actively engaged in the activity, hence the reports must be clear and concise enough to leave no doubt concerning the methods used and the interpretation of the results.

The report should be written in the past tense and in the third person. It should be impersonal throughout. Personal pronouns should be avoided. The report must be complete in itself so that it can be followed by a reader without extensive knowledge of the performance reported on. A good report is thorough, orderly, neat and grammatically correct.

Specifications:

1. Write with ink, typewriter, or computer printer.
2. Use 8½ x 11 inch paper. (Ruled paper for handwriting)
3. Write on one side of the paper only.
4. Draw all illustrations, circuit diagrams, and curves neatly and carefully.
5. Letter or type all information on drawings, circuit diagrams, and curves. Do not mix lettering styles.
6. Assemble the sheets in the order given in the following report outline. Submit the material in a standard report folder.

Report Outline:

Each section of the report will begin at the top of a new page. The sections should be arranged in the following order:

I. Title page
II. Introduction
III. Method of investigation
    A. Procedure
    B. Diagrams
IV. Results
    A. Data
        1. Nameplate data of equipment
        2. Observed and calculated data
    B. Sample calculations
    C. Curves

V. Analysis of results

VI. Questions

Report Standards:

I. Title Page

This page (see page 41) should include the name of the school, the course number and title, the date performed, the date submitted, the name of the student reporting, and the names of co-workers. This page may be omitted if the form printed on the report folder includes these items.

II. Introduction

The introduction should be a concise statement setting forth the aim and scope of the investigation.

III. Method of Investigation

A. Procedure.--In this section a general description of the procedure should be given. It should be comprehensive but brief. The enumeration and detailed description of routine mechanical operations and their sequence--such as closing switches, reading instruments, turning knobs, and so forth--should in general be avoided. However, when a specific method of mechanical operation is necessary to assure the validity or accuracy of the recorded data, it is important that the essential details be included in the description.

B. Diagrams.--Each diagram should have a figure number and should be referred to in the text material by that number. Each figure should have a descriptive title.

(Sample cover for technical report prepared by student)

(NAME OF SCHOOL)

Mechanical Technology

Production Major

Course - (No.), CAD/CAM PROBLEMS

Title: CDMP XX

Name: John Doe
(and co-workers, if applicable)

Date:

Small diagrams may be included in the body of the description, or several may be drawn on one separate sheet if they do not crowd the page. Standard symbols should be used.

IV. Results

A. Data:--The first item under results should be the nameplate data, or equivalent identification, of the apparatus.

The original observed data and the calculated data should be presented in tabular form. If the observed data require corrections, these should be made before tabulation. Equipment identification numbers and ranges need not be copied from the original laboratory data sheet.

B. Sample calculations.--This section should consist of a sample of a complete calculation of each type involved in the determination of calculated data and the solution of problems. When a succession of calculations is required in order to reach a final result, the same set of observed data should be used in carrying through the successive sample calculations; i.e., the same sample figures that are selected from a data column should be used in all calculations involving that set of data.

C. Curves.--All curve sheets should conform to the following specifications:

1. Use "twenty to the inch" coordinate paper, 8½ x 11 inches, for rectangular plots.
2. Plot in the first quadrant where only one quadrant is needed.

3. In gereral, make the axis intersect within the second part of the paper. Leave the curve sheet margins blank.
4. Plot the independent variable as abscissa and the dependent variable as ordinate.
5. In general, start the scale of the dependent variable, but not necessarily the scale of the independent variable, at zero.
6. Choose scales that are easy to use and that do not allow points to be plotted to a greater accuracy than that justified by the accuracy of the data.
7. Indicate points plotted from data by visible dots or very small circles.
8. Draw a smooth average curve through the plotted points except in cased in which discontinuities are known to exist.
9. Place a title containing all pertinent information on each curve sheet. The title should be lettered or typed. Label the axis and show the units in which they are marked.
10. Draw only related curves on the same sheet.
11. Insert curve sheets in the report so that they can be read from the bottom or right side.

V. Analysis of results

The analysis of results is the most important section of the report. As the word "analysis" implies, it should be a complete discussion of the results obtained.

Part of the discussion should deal with the accuracy or reliability of the results. It is suggested, where applicable, that this section consist of a careful treatment of the effect on the results of the following: (1) Errors resulting from the necessity of neglecting certain factors because of physical limitations, (2) errors in manipulation, (3) errors in observation, and (4) errors due to equipment malfunction.

An important part of the discussion should be a comparison of the results obtained with those which would reasonably have been expected from a consideration of the concept involved in the problem. Whenever the concept is apparently contradicted, the probable reason for conflict should be discussed.

When results are given in graphic forms as curves, the shape of each curve should be carefully explained. Such an explanation should state the causes for the particular shape the curve may have.

Any original conclusions drawn as a consequence of the laboratory procedure and a study of the results obtained should be included in this section.

VI. Questions

In this section the answers to any questions given as a part of the test should be included.

SECTION IV

FORMAT FOR MODULE GUIDES

In this section the modules to be taught in each course are presented. Each module begins on a separate page so that the it may be taken out of the guide for use in lesson planning or regrouped with other outlines of educational activities to fit the individual instructor's preference for teaching order. These modules may be used for planning and executing group instruction or for individualized instruction. Each of the MODULE GUDIES contains the following information:

MODULE COMPETENCY: This is a "stem" statement of the competency to be taught.

PERFORMANCE STATEMENT: This is the performance expected of the student after completing the unit and is also stated in stem form, i.e., without a specific statement of all conditions, equipment and performance standard.

INSTRUCTIONAL ACTIVITIES: Suggested learning activities are presented. These activities include providing information, demonstration, practical applications and projects.

INSTRUCTIONAL MATERIALS: Suggested materials for carrying out the instructional activities are listed. These include textbooks, audio-visuals, equipment and personal computer and CAD System run times. Textbooks are referenced by author and title with the complete reference contained in the textbook list in Section V.

CLASS/LAB HOURS: The estimated time for completion of the instructional activities are indicated in both classroom and laboratory hours. Total time, or contact time, would be the sum of these.

EVALUATION: This section contains a criterion referenced measure and reference to any test items or other evaluation measures that are available to the instructor.

MODULE COMPETENCY

ICAD-01 Recalling computer aided design system terminology

PERFORMANCE STATEMENT

Recall computer aided design system terminology.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Acronyms
   (1) I/O
   (2) CAD/CAM
   (3) CPU
   (4) ASC I I
   (5) K
   (6) SIGGRAPH
   (7) FORTRAN
   (8) ROM
   (9) DOS
   (10) CRT

b. Term definitions for
   (1) Bits
   (2) Byte
   (3) Memory
   (4) Syntax
   (5) Machine langugage
   (6) High-level language
   (7) Interactive computer graphics
   (8) Roster scan
   (9) Cam pilers

Term definitions (continued)
   (10) Source program
   (11) Joystick
   (12) Refresh
   (13) Directed beam
   (14) Baud rate
   (15) Interger
   (16) Binary
   (17) Terminal
   (18) Graphics terminal
   (19) Time sharing
   (20) Off line
   (21) Hardware
   (22) Software
   (23) Heradecimal
   (24) View point
   (25) Flounting point
   (26) Window
   (27) Dedicated system
   (28) Turnkey system
   (29) Batch mode graphics
   (30) Storage
   (31) Automated drafting

Provide Demonstration On:

a. Graphics input
   (1) Light pen
   (2) Graphics table
   (3) Acoustic board
   (4) Automatic raster scanner digitizer platter
   (5) Joystick

b. Computer system
   (1) Micro computer
   (2) Mini computer
   (3) Main frame

c. Interface equipment
   (1) MODEN
   (2) Bus
   (3) Parts hard wirc

d. Display devices
   (1) Printer
   (2) Plotter
   (3) Film recorder
   (4) Cathode ray table

e. Software
   (1) Programs
   (2) Cards
   (3) Firm ware

Provide Practical Application On:

Defining
a. Acronyms and terms
b. Sketching typical CAD system
   (1) Components
   (2) Operational layout
c. Matching term to operational concept and/or operational concept to term

Related Instruction:

INSTRUCTIONAL MATERIALS

Textbooks:

a. Angell, A Practical Introduction to Computer Graphics
b. Foley, Fundamentals of Interactive Computer Graphics
c. Goetsch, The CAD/CAM Workbook
d. Ryan, Computer Graphics Problem Manual
e. Scott, Introduction to Interactive Computer Graphics
f. Voisinet, Introduction to CAD

Tools and Equipment:

CAD System Run Time:

Demonstration: 3
Application: 3 per student

HOURS

Classroom: 6 Laboratory: 6

EVALUATION OF PERFORMANCE

Criterion Referenced Measure:

Given a personal computer and appropriate software, the student will recall computer aided design system terminology obtaining a minimum level of ninety percent correct on all performance items.

Suggested Testing Activities and Resources:

MODULE COMPETENCY

ICAD-02 Recalling computer aided manufacturing system terminology

PERFORMANCE STATEMENT

Recall computer aided manufacturing system terminology.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Acronyms
   (1) NC
   (2) XYZ
b. Definition of Terms
   (1) TAB
   (2) Speed
   (3) Feed
   (4) Turret stop
   (5) End of line
   (6) Interactive process design
   (7) Process physics
   (8) Simulation
   (9) Computer graphics
   (10) Forging
   (11) Extrusion
   (12) Drawing
   (13) Rolling

Provide Demonstration On:

a. The CAM process
   (1) Selection of part to be manufactured
   (2) Calling up part design from stored memory
   (3) Changing design adding and deletions to drawing, symbols and dimensions
   (4) Input of drawing to numerical control tape module
   (5) Input of tape into automated manufacturing equipment
b. Example of CAM produced parts
   (1) By casting
   (2) By extrusion
   (3) Drawing
   (4) Rolling

Provide Practical Application On:

Defining
a. Acronyms and terms
b. Sketching typical CAM system
   (1) Components
   (2) Operational layout
c. Matching term to operational concept and/or operational concept to terms

Related Instruction:

INSTRUCTIONAL MATERIALS

Textbooks:

a. Goetsch, The CAD/CAM Workbook
b. Scott, Introduction to Interactive Computer Graphics
c. Voisinet, Introduction to CAD

Audiovisuals:

DMR Associates, "CAD/CAM Basics"

Tools and Equipment:

CAM System Run Time: 1.0

HOURS

Classroom: 4 Laboratory: 6

EVALUATION OF PERFORMANCE

Criterion Referenced Measure:

Given a personal computer and appropriate software, the student will recall computer aided manufacturing system terminology obtaining minimum level of ninety percent correct on all performance items.

Suggested Testing Activities and Resources:

MODULE COMPETENCY

ICAD-03 Activating and deactivating procedures for computer aided design system

PERFORMANCE STATEMENT

Activate and deactivate procedures for computer aided design system.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Verifying
   (1) All components available
   (2) Proper interconnection of components
   (3) Connected to proper power source
   (4) No obstructions to ventilation
b. Sequence of activation place in order recommended by manufacturer. (The central processor, disk drive(s), display, printer and other components)
c. Basic pattern for initiating a program
d. Sequence for exiting a program
e. Sequence for system shut-down
f. Procedure for reporting problems with system operation

Provide Demonstration/Practical Application On:

a. Verifying all components
b. Sequence of activation
c. Initiating a program
d. Exiting a program
e. System shut-down
f. Reporting operational problems

Related Instruction:

INSTRUCTIONAL MATERIALS

Textbooks:

Manufacturers opertional manual; i.e. software for initiating/exiting the system

Audiovisuals:

Bergwall, "Initiating the Design"

Tools and Equipment:

CAD System Run Time:

Demonstration: 0.5
Application: 0.5 per student

HOURS

Classroom: 1 Laboratory: 1

EVALUATION OF PERFORMANCE

Criterion Referenced Measure:

Given a personal computer and appropriate software, the student will activate and deactivate procedures for computer aided design system obtaining a minimum level of ninety percent correct on all performance items.

Suggested Testing Activities and Resources:

MODULE COMPETENCY

ICAD-04 Running a computer aided design library program

PERFORMANCE STATEMENT

Run a computer aided design library program.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Basic commands and functions for the program selected for this module
b. Restriction to program use as applicable to this activity

Provide Demonstration/Practical Application On:

a. Initiating program
b. Menu(s)
c. All commands and functions of selected drawing activity
d. Limits of system and program
e. Exiting program

Related Instruction:

INSTRUCTIONAL MATERIALS

Textbooks:

a. Foley, Fundamentals of Interactive Computer Graphics
b. Ryan, Computer Graphics Problem Manual
c. Scott, Introduction to Interactive Computer Graphics
d. Voisinet, Introduction to CAD

Tools and Equipment:

CAD System Run Time:

Demonstration: 2.0
Application: 2.0 per student

HOURS

Classroom: 2 Laboratory: 4

EVALUATION OF PERFORMANCE

Criterion Referenced Measure:

Given a personal computer and appropriate software, the student will run a computer aided design library program obtaining a minimum level of ninety percent correct on all performance items.

Suggested Testing Activities and Resources:

MODULE COMPETENCY

ICAD-05 Using the CAD system for circle construction

PERFORMANCE STATEMENT

Use the CAD system for circle construction.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Parts of a circle
b. Types of lines used
c. Circle variables
    (1) Center point
    (2) Edge
    (3) Radius
    (4) Tongert
    (5) Ellipse
    (6) Arcs
b. Computer commands and functions needed for drawing circles
c. System limitations

Provide Demonstration/Practical Application On:

a. Outlining drawing requirements
b. Initiating program
c. Coding inputs
d. Running program
e. Modifying drawing

Related Instruction:

INSTRUCTIONAL MATERIALS

Textbooks:

a. Angell, A Practical Introduction to Computer Graphics
b. Foley, Fundamentals of Interactive Computer Graphics
c. Ryan, Computer Graphics Problem Manual
d. Scott, Introduction to Interactive Computer Graphics
e. Voisinet, Introduction to CAD

Audiovisuals:

Bergwall, "Developing the Design"

Tools and Equipment:

CAD System Run Time:

Demonstration: 1.5
Application: 1.5 per student

HOURS

Classroom: 1 Laboratory: 3

EVALUATION OF PERFORMANCE

Criterion Referenced Measure:

Given a personal computer and appropriate software, the student will use the CAD system for circle construction obtaining a minimum level of ninety percent correct on all performance items.

Suggested Testing Activities and Resources:

MODULE COMPETENCY

ICAD-06 Constructing a spline

PERFORMANCE STATEMENT

Construct a spline.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Definition of spline
b. Alphanumeric input sequence
c. Digitizing sequence STREAM mode
d. Using light pen
e. Advantages and disadvantages of various modes

Provide Demonstration/Practical Application On:

a. Spline construction using
   (1) Alphanumerical imput
   (2) Digitizing method
   (3) The light pen
b. Drawing a spline to meet required specifications using the available modes

Related Instruction:

INSTRUCTIONAL MATERIALS

Textbooks:

a. Angell, A Practical Introduction to Computer Graphics
b. Foley, Fundamentals of Interactive Computer Graphics
c. Scott, Introduction to Interactive Computer Graphics
d. Voisinet, Introduction to CAD

Tools and Equipment:

CAD System Run Time:

Demonstration: 1.5
Application: 1.5 per student

HOURS

Classroom: 1 Laboratory: 3

EVALUATION OF PERFORMANCE

Criterion Referenced Measure:

Given a personal computer and appropriate software, the student will construct a spline obtaining a minimum level of ninety percent correct on all performance items.

Suggested Testing Activities and Resources:

MODULE COMPETENCY

ICAD-07 Drawing dimensional lines and inserting descriptive symbols

PERFORMANCE STATEMENT

Draw dimensional lines and insert descriptive symbols.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Drawing dimensional lines using
   (1) Alphanumerical input with function board
   (2) Digitizing method
   (3) Light pen method
b. Inserting text using
   (1) Alphanumerical input with function board
   (2) Digitizing method
   (3) Light pen method

Provide Demonstration/Practical Application On:

Drawing lines and inserting text using the following methods
(1) Alphanumerical input with function board
(2) Digitizing method
(3) Light pen method

Related Instruction:

INSTRUCTIONAL MATERIALS

Textbooks:

a. Angell, A Practical Introduction to Computer Graphics
b. Foley, Fundamentals of Interactive Computer Graphics
c. Goetsch, The CAD/CAM Workbook
d. Ryan, Computer Graphics Problem Manual
e. Scott, Introduction to Interactive Computer Graphics
f. Voisinet, Introduction to CAD

Audiovisuals:

Bergwall, "Dimensioning the Design"

Tools and Equipment:

CAD System Run Time:

Demonstration: 1.0
Application: 2.0 per student

HOURS	
Classroom: 2	Laboratory: 3

EVALUATION OF PERFORMANCE

Criterion Referenced Measure:

Given a personal computer and appropriate software, the student will draw dimensional lines and insert descriptive symbols obtaining a minimum level of ninety percent correct on all performance items.

Suggested Testing Activities and Resources:

MODULE COMPETENCY

ICAD-08 Using geometry modifiers to alter drawings

PERFORMANCE STATEMENT

Use geometry modifiers to alter drawings.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Command function used for modifiers: Example, CHANGE, ALTER, RELIMIT
b. Peripheral equipment involved
   (1) Keyboard
   (2) Joystick/thumbwheel
   (3) Graphic tablet
   (4) Light pen
c. Range advantages/disadvantages of selected mode

Provide Demonstration/Practical Application On:

a. Altering a drawing using the systems geometry modifiers
b. Employing all types of peripheral equipment available to stress system capability/limitations

Related Instruction:

INSTRUCTIONAL MATERIALS

Textbooks:

a. Angell, A Practical Introduction to Computer Graphics
b. Foley, Fundamentals of Interactive Computer Graphics
c. Goetsch, The CAD/CAM Workbook
d. Ryan, Computer Graphics Problem Manual
e. Scott, Introduction to Interactive Computer Graphics
f. Voisinet, Introduction to CAD

Tools and Equipment:

CAD System Run Time:

Demonstration: 1.0
Application: 2.0 per student

HOURS

Classroom: 2 Laboratory: 3

EVALUATION OF PERFORMANCE

Criterion Referenced Measure:

Given a personal computer and appropriate software, the student will use geometry modifiers to alter drawings obtaining a minimum level of ninety percent correct on all performance items.

Suggested Testing Activities and Resources:

MODULE COMPETENCY

ICAD-09 Using the function board to produce a mechanical drawing

PERFORMANCE STATEMENT

Use the function board to produce a mechanical drawing.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Minimum number of bytes system must possess for types of drawings undertaken
b. Commands available at function board
c. Differences in commands among various CAD systems
d. Decision to produce hand copy
e. Equipment needed to gain hard copy of drawing

Provide Demonstration/Practical Application On:

a. Function board command buttons
b. Data entry and command sequence
c. Moving elements of the drawing
d. Deleting elements
e. Scaling elements
f. Procedure to produce hard copy

Related Instruction:

INSTRUCTIONAL MATERIALS

Textbooks:

a. Angell, A Practical Introduction to Computer Graphics
b. Foley, Fundamentals of Interactive Computer Graphics
c. Goetsch, The CAD/CAM Workbook
d. Ryan, Computer Graphics Problem Manual
e. Scott, Introduction to Interactive Computer Graphics
f. Voisinet, Introduction to CAD

Tools and Equipment:

CAD System Run Time:

Demonstration: 1.0
Application: 1.0 per student

HOURS

Classroom: 1 Laboratory: 2

EVALUATION OF PERFORMANCE

Criterion Referenced Measure:

Given a personal computer and appropriate software, the student will use the function board to produce a mechanical drawing obtaining a minimum level of ninety percent correct on all performance items.

Suggested Testing Activities and Resources:

MODULE COMPETENCY

ICAD-10 Using the function board to produce a schematic diagram

PERFORMANCE STATEMENT

Use the function board to produce a schematic diagram.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Call-up of graphic representations (symbols)
   (1) Command buttons
   (2) Alphanumerical keyboard
b. Adding text to drawing
c. Programs available for schematic diagram for
   (1) Electrical
   (2) Electronic
   (3) Piping
   (4) Hydraulics
   (5) Metal work

Provide Demonstration/Practical Application On:

a. Loading program
b. Program menu
c. Call-up and positioning symbols
d. Adding interconnecting lines
e. Labeling text
f. Changing programs to produce combinations of various systems on one drawing

Related Instruction:

INSTRUCTIONAL MATERIALS

Textbooks:

a. Ryan, Computer Graphics Problem Manual
b. Voisinet, Introduction to CAD

Tools and Equipment:

CAD System Run Time:

Demonstration: 1.0
Application: 1.0 per student

HOURS

Classroom: 1 Laboratory: 2

EVALUATION OF PERFORMANCE

Criterion Referenced Measure:

Given a personal computer and appropriate software, the student will use the function board to produce a schematic diagram obtaining a minimum level of ninety percent correct on all performance items.

Suggested Testing Activities and Resources:

MODULE COMPETENCY

ICAD-11 Using the graphics table to produce mechanical and piping diagrams

PERFORMANCE STATEMENT

Use the graphics table to produce mechanical and piping diagrams.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Digitizing mode
b. Establishing drawing boundary
c. Menus of program(s) used
d. Examples of drawing produced
e. System limitations

Provide Demonstration/Practical Application On:

a. Digitizing
b. Menus available and how/where to access
c. Data input
    (1) Elements
    (2) Dimension lines
    (3) Text
d. Producing a mechanical drawing
e. Producing a piping drawing
f. Producing a combination drawing

Related Instruction:

INSTRUCTIONAL MATERIALS

Textbooks:

a. Scott, Introduction to Interactive Computer Graphics
b. Voisinet, Introduction to CAD

Tools and Equipment:

CAD System Run Time:

Demonstration: 1.0
Application: 2.0 per student

HOURS

Classroom: 1 Laboratory: 3

EVALUATION OF PERFORMANCE

Criterion Referenced Measure:

Given a personal computer and appropriate software, the student will use the graphics table to produce mechanical and piping diagrams obtaining a minimum level of ninety percent correct on all performance items.

Suggested Testing Activities and Resources:

MODULE COMPETENCY

ICAD-12 Using the light pen to produce a mechanical drawing

PERFORMANCE STATEMENT

Use the light pen to produce a mechanical drawing.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Methods available
   (1) Alphanumerical keys
   (2) Light pen establishing end points
   (3) Light pen to produce continuous line
b. Program capability and limits
   (1) Elements
   (2) Symbols
c. Examples of drawing produced using this mode

Provide Demonstration/Practical Application On:

a. Line production using
   (1) Alphanumerical keys
   (2) Light pen, point to point mode
   (3) Light pen, continuous line mode
b. Producing a mechanical drawing using the light pen
   (1) Elements
   (2) Dimensions
   (3) Symbols
   (4) Text (note limitation)

Related Instruction:

INSTRUCTIONAL MATERIALS

Textbooks:

a. Ryan, Computer Graphics Problem Manual
b. Scott, Introduction to Interactive Computer Graphics
c. Voisinet, Introduction to CAD

Tools and Equipment:

CAD System Run Time:

Demonstration: 2.0
Application: 2.0 per student

HOURS

Classroom: 1 Laboratory: 4

EVALUATION OF PERFORMANCE

Criterion Referenced Measure:

Given a personal computer and appropriate software, the student will use the light pen to produce a mechanical drawing obtaining a minimum level of ninety percent correct on all performance items.

Suggested Testing Activities and Resources:

MODULE COMPETENCY

ICAD-13 Using a joystick to develop symbols

PERFORMANCE STATEMENT

Use a joystick to develop symbols.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Rationale for developing symbols
b. Methods of storing
c. Alternate methods of developing symbols
d. Capabilities/limitations of this mode
    (1) Scale
    (2) Accuracy
e. Examples of drawings produced in this mode

Provide Demonstration/Practical Application On:

a. Activating system
b. Scale decision
c. Accuracy decision
d. Program prompt keys
e. Producing symbols
f. Storing procedure

Related Instruction:

INSTRUCTIONAL MATERIALS

Textbooks:

a. Ryan, Computer Graphics Problem Manual
b. Scott, Introduction to Interactive Computer Graphics
c. Voisinet, Introduction to CAD

Tools and Equipment:

CAD System Run Time:

Demonstration: 0.5
Application: 1.5 per student

HOURS

Classroom: 3 Laboratory: 3

EVALUATION OF PERFORMANCE

Criterion Referenced Measure:

Given a personal computer and appropriate software, the student will use a joystick to develop symbols obtaining a minimum level of ninety percent correct on all performance items.

Suggested Testing Activities and Resources:

MODULE COMPETENCY

ICAD-14 Modifying existing drawing data

PERFORMANCE STATEMENT

Modify existing drawing data.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Modifier commands
   (1) ERASE
   (2) DELETE
   (3) REDRAW
   (4) SHIFT
   (5) SCALE or SIZE
b. Type of input
   (1) Keyboard
   (2) Function board
   (3) Light pen

Provide Demonstration/Practical Application On:

a. Modifying drawing elements
   (1) By DELETE mode
   (2) By REDRAW mode
   (3) By SHIFT mode
   (4) By SCALE or SIZE mode
b. Variation of data input
   (1) By use of function board
   (2) By use of light pen
c. The use of ERASE to remove
   (1) Complete image
   (2) Partial image

Related Instruction:

INSTRUCTIONAL MATERIALS

Textbooks:

a. Goetsch, The CAD/CAM Workbook
b. Ryan, Computer Graphics Problem Manual
c. Scott, Introduction to Interactive Computer Graphics
d. Voisinet, Introduction to CAD

Tools and Equipment:

CAD System Run Time:

Demonstration: 0.5
Application: 1.0 per student

HOURS	
Classroom: 1	Laboratory: 1.5

EVALUATION OF PERFORMANCE

Criterion Referenced Measure:

Given a personal computer and appropriate software, the student will modify existing drawing data obtaining a minimum level of ninety percent correct on all performance items.

Suggested Testing Activities and Resources:

MODULE COMPETENCY

ICAD-15 Preserving computer data used for producing drawing

PERFORMANCE STATEMENT

Preserve computer data used for producing drawing.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Methods of saving or filing computer data
   (1) Tape storage
   (2) Disk storage
b. Physical safeguards for protecting software
   (1) Tapes
   (2) Disks
c. Recalling data
   (1) Tape method
   (2) Disk method

Provide Demonstration/Practical Application On:

a. Method on-hand system used to save drawing data
b. Procedure for safeguarding software which has been removed from the system
c. Retrieval of software
   (1) Indexing/cataloging
   (2) Accountability
d. Recalling data

Related Instruction:

INSTRUCTIONAL MATERIALS

Textbooks:

a. Scott, Introduction to Interactive Computer Graphics
b. Voisinet, Introduction to CAD

Tools and Equipment:

CAD System Run Time:

Demonstration: 0.5
Application: 0.5 per student

HOURS

Classroom: 2 Laboratory: 1

EVALUATION OF PERFORMANCE

Criterion Referenced Measure:

Given a personal computer and appropriate software, the student will preserve computer data used for producing drawing obtaining a minimum level of ninety percent correct on all performance items.

Suggested Testing Activities and Resources:

MODULE COMPETENCY

CADA-01 Operating the CAD system at the "Introductory Level"

PERFORMANCE STATEMENT

Operate the CAD system at the "Introductory Level".

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Methods and procedures used to evaluate objective
   (1) Paper/pencil examination on terminology, operational theory, and operational sequence
   (2) Student produced drawings encompassing each of the drawing skills gained in introductory course
b. Requirement(s) for repeating the introductory level course or repeating selected modules therein

Provide Demonstration on:

None

Provide Practical Application On:

Completing a domain reference test which surveys the course competencies mastered in completing the Introduction to CAD course
(1) Paper/pencil examination on
   (a) Terminology
   (b) Operational theory
   (c) Operational sequence
(2) Using CAD system to produce drawings which illustrate possession of performance skills

Related Instruction:

INSTRUCTIONAL MATERIALS

Textbooks:

Those references which are linked with job sheets and other similar instruments used in evaluating Introduction to CAD course competencies.

Tools and Equipment:

CAD Systen Run Time:

Demonstration: 0.0
Application: 6 per student

HOURS	
Classroom: 0	Laboratory: 6

EVALUATION OF PERFORMANCE

Criterion Referenced Measure:

Given a personal computer and appropriate software, the student will operate the CAD system at the "Introductory Level" obtaining a minimum level of ninety percent correct on all performance items.

Suggested Testing Activities and Resources:

MODULE COMPETENCY

CADA-02 Using the CAD system to section drawings

PERFORMANCE STATEMENT

Use the CAD system to section drawings.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Conventional sectioning techniques
b. Cutting plane
c. Cross-hatching
    (1) Using function board
    (2) Using light pen with function board

Provide Demonstration/Practical Application On:

a. Sketching the sectional drawing
b. Establishing boundaries
c. Selecting type of cross-hatch from the XHATCH menu
d. Selecting direction
e. Executing the cross-hatching

Related Instruction:

INSTRUCTIONAL MATERIALS

Textbooks:

Voisinet, Introduction to CAD

Tools and Equipment:

CAD System Run Time:

Demonstration: 0.5
Application: 1.0 per student

HOURS

Classroom: 0.5 Laboratory: 1.5

EVALUATION OF PERFORMANCE

Criterion Referenced Measure:

Given a personal computer and appropriate software, the student will use the CAD system to section drawings obtaining a minimum level of ninety percent correct on all performance items.

Suggested Testing Activities and Resources:

MODULE COMPETENCY

CADA-03 Using the CAD system to create auxiliary views

PERFORMANCE STATEMENT

Use the CAD system to create auxiliary views.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Constructing the auxiliary view using the geometry generators
b. Using the auxiliary view function of CAD systems if so equipped

Provide Demonstration/Practical Application On:

a. Constructing the auxiliary view using the geometry generators
b. Using the auxiliary view function of the CAD system if so equipped

Related Instruction:

INSTRUCTIONAL MATERIALS

Textbooks:

a. Foley, Fundamentals of Interactive Computer Graphics
b. Voisinet, Introduction to CAD

Tools and Equipment:

CAD System Run Time:

Demonstration: 1.0
Application: 1.0 per student

HOURS

Classroom: 1 Laboratory: 2

EVALUATION OF PERFORMANCE

Criterion Referenced Measure:

Given a personal computer and appropriate software, the student will use the CAD system to create auxiliary views obtaining a minimum level of ninety percent correct on all performance items.

Suggested Testing Activities and Resources:

MODULE COMPETENCY

CADA-04 Using the CAD system rotate command to reposition object(s)

PERFORMANCE STATEMENT

Use the CAD system rotate command to reposition object(s).

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Two-dimensional rotation
   (1) Function board procedure
   (2) Function board and light pen procedure
b. Clockwise and counterclockwise rotation
c. Examples of drawings produced using these procedures

Provide Demonstration/Practical Application On:

a. Producing a two-dimensional drawing by using the system rotation feature
b. Variations of movement; e.g., clockwise and counter-clockwise rotation

Related Instruction:

INSTRUCTIONAL MATERIALS

Textbooks:

a. Angell, A Practical Introduction to Computer Graphics
b. Foley, Fundamentals of Interactive Computer Graphics
c. Scott, Introduction to Interactive Computer Graphics
d. Voisinet, Introduction to CAD

Tools and Equipment:

CAD System Run Time:

Demonstration: 0.5
Application: 1.5

HOURS

Classroom: 1 Laboratory: 2

EVALUATION OF PERFORMANCE

Criterion Referenced Measure:

Given a personal computer and appropriate software, the student will use the CAD system rotate command to reposition object(s) obtaining a minimum level of ninety percent correct on all performance items.

Suggested Testing Activities and Resources:

MODULE COMPETENCY

CADA-05 Producing three-dimensional object drawing

PERFORMANCE STATEMENT

Produce three-dimensional object drawing.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Using 2-D system to create isometric drawings
b. Examples of drawings produced using the 2-D system
c. Creating a 3-D drawing using the CAD system program
d. Examples of drawings produced using the 3-D capability
e. Rotating 3-D drawings
f. Modeling features

Provide Demonstration/Practical Application On:

a. Creating an isometric drawing with a 2-D program
b. Creating a 3-D drawing using the systems 3-D capabilities rotation and modeling
c. Producing a 3-D object drawing in the following categories
   (1) Mechanical object
   (2) Piping
   (3) Architectural

Related Instruction:

INSTRUCTIONAL MATERIALS

Textbooks:

a. Angell, A Practical Introduction to Computer Graphics
b. Foley, Fundamentals of Interactive Computer Graphics
c. Ryan, Computer Graphics Problem Manual
d. Scott, Introduction to Interactive Computer Graphics
e. Voisinet, Introduction to CAD

Tools and Equipment:

CAD System Run Time:

Demonstration: 1.0
Application: 3.0 per student

HOURS

Classroom: 1 Laboratory: 3

EVALUATION OF PERFORMANCE

Criterion Referenced Measure:

Given a personal computer and appropriate software, the student will produce three-dimensional object drawing obtaining a minimum level of ninety percent correct on all performance items.

Suggested Testing Activities and Resources:

MODULE COMPETENCY

CADA-06 Using special modification features of the CAD system

PERFORMANCE STATEMENT

Use special modification features of the CAD system.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Capability of different CAD systems
   (1) Hardware
   (2) Software
b. Capability of on-hand system(s)
   (1) Hardware
   (2) Software
c. Examples of drawings modified by using the system

Provide Demonstration/Practical Application On:

a. System capability to perform special modification functions
b. Producing a drawing which utilized use of special modification features

Related Instruction:

INSTRUCTIONAL MATERIALS

Textbooks:

a. System hardware manual
b. System software instructions
c. Voisinet, Introduction to CAD

Tools and Equipment:

CAD System Run Time:

Demonstration: 1.0
Application: 2.0 per student

HOURS

Classroom: 1 Laboratory: 3

EVALUATION OF PERFORMANCE

Criterion Referenced Measure:

Given a personal computer and appropriate software, the student will use special modification features of the CAD system obtaining a minimum level of ninety percent correct on all performance items.

Suggested Testing Activities and Resources:

MODULE COMPETENCY

CADA-07 Using the CAD system to produce a bill of materials

PERFORMANCE STATEMENT

Use the CAD system to produce a bill of materials.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Capability of different CAD systems
   (1) Hardware
   (2) Software
b. Capability of on-hand system(s)
   (1) Hardware
   (2) Software
c. Examples of bill of material produced by the CAD system

Provide Demonstration/Practical Application On:

System capability to generate a bill of materials
(1) Hardware controls
(2) Software procedures

Related Instruction:

INSTRUCTIONAL MATERIALS

Textbooks:

a. Gunn, Computer Applications in Manufacturing
b. Scott, Introduction to Interactive Computer Graphics
c. Voisinet, Introduction to CAD

Tools and Equipment:

CAD System Run Time:

Demonstration: 1.0
Application: 2.0 per student

HOURS

Classroom: 1 Laboratory: 3

EVALUATION OF PERFORMANCE

Criterion Referenced Measure:

Given a personal computer and appropriate software, the student will use the CAD system to produce a bill of materials obtaining a minimum level of ninety percent correct on all performance items.

Suggested Testing Activities and Resources:

MODULE COMPETENCY

CADA-08 Using the CAD system to produce a two-dimensional drawing

PERFORMANCE STATEMENT

Use the CAD system to produce a two-dimensional drawing.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Procedure for generating a two-dimensional mechanical drawing
   (1) Line drawing from an engineering sketch
   (2) Finished hardcopy for
      (a) Machine parts
      (b) Small commercial building
      (c) Electronic circuit board component parts layout
b. Examples of two-dimensional drawings produced by the CAD system

Provide Demonstration:

Those items of hardware and software which have not been previously demonstrated

Provide Practical Application On:

Producing a minimum of one drawing of each of the following
(1) Line diagram from an engineering sketch
(2) All machine parts used in a complete assembly/ product
(3) Small commercial building
(4) Electronic circuit component layout

Related Instruction:

INSTRUCTIONAL MATERIALS

Textbooks:

a. CAD system handbook
b. Program (software) instructions
c. Engineering standards

Tools and Equipment:

CAD System Run Time:

Demonstration: 0.5
Application: 8.0 per student

HOURS	
Classroom: 0.5	Laboratory: 8.5

EVALUATION OF PERFORMANCE

Criterion Referenced Measure:

Given a personal computer and appropriate software, the student will use the CAD system to produce a two-dimensional drawing obtaining a minimum level of ninety percent correct on all performance items.

Suggested Testing Activities and Resources:

MODULE COMPETENCY

CADA-09 Using the CAD system to produce a three-dimensional drawing

PERFORMANCE STATEMENT

Use the CAD system to produce a three-dimensional drawing.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Procedure for generating a three-dimensional mechanical drawing
   (1) Line drawing from an engineering sketch
   (2) Finished hardcopy for
      (a) Machine parts
      (b) Small commercial building
      (c) Electronic circuit board component parts layout
b. Examples of three-dimensional drawings produced by the CAD system

Provide Demonstration On:

Those items of hardware and software which have not been previously demonstrated

Provide Practical Application On:

Producing a minimum of one drawing of each of the following
(1) Line diagram from an engineering sketch
(2) All machine parts used in a complete assembly/ product
(3) Small commercial building
(4) Electronic circuit component layout

Related Instruction:

INSTRUCTIONAL MATERIALS

Textbooks:

a. CAD system handbook
b. Program (software) instructions
c. Engineering standards

Tools and Equipment:

CAD System Run Time:

Demonstration: 0.5
Application: 6.0 per student

HOURS	
Classroom: 0.5	Laboratory: 6.5

EVALUATION OF PERFORMANCE

Criterion Referenced Measure:

Given a personal computer and appropriate software, the student will use the CAD system to produce a three-dimensional drawing obtaining a minimum level of ninety percent correct on all performance items.

Suggested Testing Activities and Resources:

MODULE COMPETENCY

CADA-10 Using the CAD system to produce a two-dimensional diagram

PERFORMANCE STATEMENT

Use the CAD system to produce a two-dimensional diagram.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Procedure for generating a two dimensional piping diagram
   (1) Line diagram from an engineering sketch
   (2) Finished hardcopy for
      (a) Commercial building
      (b) Civil construction
b. Examples of two-dimensional diagrams produced by the CAD system

Provide Demonstration On:

Those items of hardware and software which have not been previously demonstrated

Provide Practical Application On:

Producing a minimum of one piping diagram of each of the following
(1) Line diagram from an engineering sketch
(2) Commercial building
(3) Civil construction

Related Instruction:

INSTRUCTIONAL MATERIALS

Textbooks:

a. CAD system handbook
b. Program (software) instructions
c. Engineering standards

Tools and Equipment:

CAD System Run Time:

Demonstration: 0.5
Application: 6.0 per student

HOURS	
Classroom: 0.5	Laboratory: 6.5

EVALUATION OF PERFORMANCE

Criterion Referenced Measure:

Given a personal computer and appropriate software, the student will use the CAD system to produce a two-dimension piping diagram obtaining a minimum level of ninety percent correct on all performance items.

Suggested Testing Activities and Resources:

MODULE COMPETENCY

CADA-11 Using the CAD system to produce a three-dimensional commercial building and civil drawings

PERFORMANCE STATEMENT

Use the CAD system to produce three-dimensional commercial building and civil drawings.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Procedure for generating a three-dimensional piping drawing
   (1) Commercial building
   (2) Civil construction
b. Examples of three-dimensional piping drawings produced by the CAD system

Provide Demonstration On:

Those items of hardware and software which have not been previously demonstrated

Provide Practical Application On:

Producing a minimum of one three-dimensional drawing of
(1) Commercial building
(2) Civil construction

Related Instruction:

INSTRUCTIONAL MATERIALS

Textbooks:

a. CAD system handbook
b. Program (software) instructions
c. Engineering standards

Tools and Equipment:

CAD System Run Time:

Demonstration: 0.5
Application: 6.0 per student

HOURS	
Classroom: 0.5	Laboratory: 6.5

EVALUATION OF PERFORMANCE

Criterion Referenced Measure:

Given a personal computer and appropriate software, the student will use the CAD system to produce three-dimensional commercial building and civil drawings obtaining a minimum level of ninety percent correct on all performance items.

Suggested Testing Activities and Resources:

MODULE COMPETENCY

CADA-12 Using the CAD system to produce an electronic assembly component parts layout drawing

PERFORMANCE STATEMENT

Use the CAD system to produce an electronic assembly component parts layout drawing.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Procedure for generating the drawing
   (1) Engineering sketch
   (2) Program capability to produce specific sized symbolic shapes
   (3) Method of generating new symbolic shapes
   (4) Two-dimensional representation
   (5) Three-dimensional representation
b. Examples of electronic assembly component layout drawings produced by the CAD system

Provide Demonstration On:

Those items of hardware and software which have not been previously demonstrated

Provide Practical Application On:

Producing a minimum of one drawing
(1) Two-dimensional format
(2) Three-dimensional format

Related Instruction:

INSTRUCTIONAL MATERIALS

Textbooks:

a. CAD system handbook
b. Program (software) instructions
c. Engineering standards

Tools and Equipment:

CAD System Run Time:

Demonstration: 0.5
Application: 6 per student

HOURS	
Classroom: 0.5	Laboratory: 6.5

EVALUATION OF PERFORMANCE

Criterion Referenced Measure:

Given a personal computer and appropriate software, the student will use the CAD system to produce an electronic assembly component parts layout drawing obtaining a minimum level of ninety percent correct on all performance items.

Suggested Testing Activities and Resources:

MODULE COMPETENCY

CADA-13 Using the CAD system to produce schematic diagrams

PERFORMANCE STATEMENT

Use the CAD system to produce schematic diagrams.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Procedure for generating various types of schematic diagrams
   (1) Electronic
   (2) Hydraulic
   (3) Piping
   (4) Welding
b. Examples of schematic diagrams for each type reviewed (These examples are hard copies from the CAD system)

Provide Demonstration On:

Those items of hardware and software which have not been previously demonstrated

Provide Practical Application On:

Producing a minimum of one schematic diagram for each type selected for study

Related Instruction:

INSTRUCTIONAL MATERIALS

Textbooks:

a. CAD system handbook
b. Program (software) instructions
c. Engineering standards

Tools and Equipment:

CAD System Run Time:

Demonstration: 0.5
Application: 8.0

HOURS

Classroom: 0.5 Laboratory: 8.5

EVALUATION OF PERFORMANCE

Criterion Referenced Measure:

Given a personal computer and appropriate software, the student will use the CAD system to produce schematic diagrams obtaining a minimum level of ninety percent correct on all performance items.

Suggested Testing Activities and Resources:

MODULE COMPETENCY

CADA-14 Using the CAD system to produce multiple-plate two-dimensional drawings of a CAM process product

PERFORMANCE STATEMENT

Use the CAD system to produce multiple-plate two-dimensional drawings of a CAM process product.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Detailing of drawings production sequence
   (1) Engineering sketch review
   (2) Initial set
   (3) Engineering verification
   (4) Change/modification
   (5) Final review
   (6) Finished hard copy
b. Examples of two-dimensional drawing producd by on-hand CAD system

Provide Demonstration On:

Those items of hardware and software which have not been previously demonstrated

Provide Practical Appliction On:

Producing
(1) Initial set
(2) Revised set
(3) Finished set

Related Instruction:

INSTRUCTIONAL MATERIALS

Textbooks:

a. CAD system handbook
b. Program (software) instructions
c. Engineering standards

Tools and Equipment:

CAD System Run Time:

Demonstration: 0.5
Application: 5.0

HOURS	
Classroom: 0.5	Laboratory: 5.5

EVALUATION OF PERFORMANCE

Criterion Referenced Measure:

Given a personal computer and appropriate software, the student will use the CAD system to produce multiple-plate two-dimensional drawings of a CAM process product obtaining a minimum level of ninety percent correct on all performance items.

Suggested Testing Activities and Resources:

MODULE COMPETENCY

CADA-15 Using the CAD system to produce multiple-plate three-dimensional drawings of a CAM process product

PERFORMANCE STATEMENT

Use the CAD system to produce multiple-plate three-dimensional drawings of a CAM process product.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Detailing of drawings production sequence
   (1) Engineering sketch review
   (2) Initial set
   (3) Engineering verification
   (4) Change/modification
   (5) Final review
   (6) Finished hard copy
b. Examples of three-dimensional drawings of a CAM process product which have been produced by the on-hand CAD system

Provide Demonstration On:

Those items of hardware and software which have not been previously demonstrated

Provide Practical Application On:

Producing
(1) Initial set
(2) Revised set
(3) Finished set

Related Instruction:

INSTRUCTIONAL MATERIALS

Textbooks:

a. CAD system handbook
b. Program (software) instructions
c. Engineering standards

Tools and Equipment:

CAD System Run Time:

Demonstration: 0.5
Application: 5.0

HOURS	
Classroom: 0.5	Laboratory: 5.5

EVALUATION OF PERFORMANCE

Criterion Referenced Measure:

Given a personal computer and appropriate software, the student will use the CAD system to produce multiple-plate three-dimensional drawings of a CAM process product obtaining a minimum level of ninety percent correct on all performance items.

Suggested Testing Activities and Resources:

MODULE COMPETENCY

CAMF-01 Recalling computer aided manufacturing process terminology

PERFORMANCE STATEMENT

Recall computer aided manufacturing process terminology.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Process functions
   (1) Accounting
   (2) Data processing
   (3) Designing
   (4) Distribution
   (5) Finance
   (6) Legal
   (7) Manufacturing
   (8) Marketing
   (9) Materials control
   (10) Personnel management
   (11) Purchasing
   (12) Quality control
   (13) Research and development
   (14) Sales and advertising
b. Categories of manufacturing
   (1) Process
   (2) Discrete
c. Financial considerations
   (1) Assets
   (2) Liabilities
   (3) Revenue
   (4) Earnings
   (5) Taxes
   (6) Income
d. Production cost
   (1) Labor
   (2) Overhead
   (3) Materials
e. Computer-based manufacturing
   (1) Inventory levels
   (2) Sales and service
   (3) Production
   (4) Maintenance

Provide Demonstration On:

a. Manual management system
   (1) Forms and graphics
   (2) Generating records
   (3) File and retrieval
b. Computer-based management system
   (1) Hardware
   (2) Software
   (3) Procedures
   (4) Security
   (5) Limitations

Provide Practical Application On:

a. Matching terms to definitions
b. Matching definitions to terms
c. Completing statements by recalling terms
d. Writing a description of portions of the manufacturing process using all of the terms supplied

Related Instruction:

INSTRUCTIONAL MATERIALS

Textbooks:

Ginn, Computer Applications in Manufacturing

Tools and Equipment:

Personal Computer Run Time:

Demonstration: 1.0
Application: 0.0

HOURS

Classroom: 3 Laboratory: 3

EVALUATION OF PERFORMANCE

Criterion Referenced Measure:

Given a personal computer and appropriate software, the student will recall computer aided manufacturing process terminology obtaining a minimum level of ninety percent correct on all performance items.

Suggested Testing Activities and Resources:

MODULE COMPETENCY

CAMF-02 Recalling procedural steps involved in generating a bill of materials

PERFORMANCE STATEMENT

Recall procedural steps involved in generating a bill of materials.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Structuring the bill of materials
   (1) Product relationship
   (2) Parent-child relationship
   (3) By level(s)
   (4) Part explosion
   (5) Part unplosion
b. Modification to structure
   (1) Engineering changes
   (2) Phantom bill
c. Managing systems
   (1) Central department
   (2) Product manager
   (3) Division manager

Provide Demonstration On:

a. Software used to computer-base managed bill of materials
b. Procedure for updating

Provide Practical Application On:

a. Creating a computer-based managed bill of materials
b. Modifying the structure
c. Generating the procedural steps needed to maintain system integrity

Related Instruction:

INSTRUCTIONAL MATERIALS

Textbooks:

Gunn, Computer Applications in Manufacturing

Tools and Equipment:

Personal Computer Run Time:

Demonstration: 0.5
Application: 1.0 per student

HOURS	
Classroom: 0.5	Laboratory: 1.5

EVALUATION OF PERFORMANCE

Criterion Referenced Measure:

Given a personal computer and appropriate software, the student will recall procedural steps involved in generating a bill of materials obtaining a minimum level of ninety percent correct on all performance items.

Suggested Testing Activities and Resources:

MODULE COMPETENCY

CAMF-03 Recalling data requirements for computer aided manufacturing

PERFORMANCE STATEMENT

Recall data requirements for computer aided manufacturing.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Routing/process forms
b. Time accounting
    (1) Labor
    (2) Machine run
    (3) Transportation
    (4) Idle
c. Costs factoring
d. Cataloging
    (1) Raw materials
    (2) Sub-port
    (3) Port
    (4) Assembly
    (5) Operational unit
e. Inventory control

Provide Demonstration On:

a. Manual software (tickets and forms)
b. Computer programs for
    (1) Tune accounting
    (2) Costs analysis
    (3) Cataloging
    (4) Inventory control

Provide Practical Application On:

a. Manual systems of data requirements
b. Computer-based data collection
    (1) Time accounting
    (2) Cost analsysis
    (3) Cataloging
    (4) Inventory control

Related Instruction:

INSTRUCTIONAL MATERIALS

Textbooks:

Gunn, Computer Applications in Manufacturing

Tools and Equipment:

Personal Computer Run Time:

Demonstration: 1.0
Application: 3.0 per student

HOURS

Classroom: 0.5 Laboratory: 4.0

EVALUATION OF PERFORMANCE

Criterion Referenced Measure:

Given a personal computer and appropriate software, the student will recall data requirements for computer aided manufacturing obtaining a minimum level of ninety percent correct on all performance items.

Suggested Testing Activities and Resources:

MODULE COMPETENCY

CAMF-04 Writing material requirements planning procedures

PERFORMANCE STATEMENT

Write material requirements planning procedures.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. "Big MRP" manufacturing resource planning
b. "Little MRP" materials requirement planning
    (1) Concept
    (2) Dependent-parts demand
    (3) Independent-parts demand
    (4) Order/re-order inventory control
c. MRP scheduling process
d. Reports format
e. MRP netting logic
f. Control of priority spares
g. Multi-level requirements
    (1) Low-level coding
    (2) Bill of materials impact
h. Net change or representative system decision
i. Lot size determination

Provide Demonstration On:

a. The MRP scheduling process
b. The MRP report formats
c. Computing MRP netting
d. Coding of low-level control point
e. Lot sizing formulas

Provide Practical Application On:

Writing the MRP which include
(1) Scheduling process
(2) Selection of report formats
(3) Method of computing netting
(4) Procedure for coding low-level point
(5) Illustrating use of lot-sizing formulas

Related Instruction:

INSTRUCTIONAL MATERIALS

Textbooks:

Gunn, Computer Applications in Manufacturing

Tools and Equipment:

Personal Computer Run Time:

Demonstration: 1.0
Application: 2.0 per student

HOURS

Classroom: 2.0 Laboratory: 6.0

EVALUATION OF PERFORMANCE

Criterion Referenced Measure:

Given a personal computer and appropriate software, the student will write material requirements planning procedures obtaining a minimum level of ninety percent correct on all performance items.

Suggested Testing Activities and Resources:

MODULE COMPETENCY

CAMF-05 Developing a draft of the production planning process

PERFORMANCE STATEMENT

Develop a draft of the production planning process.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Production planning process
   (1) Input data
   (2) Output data
b. The master production schedule
   (1) Material requirements
   (2) Capacity requirements
   (3) Feedback
   (4) Purchasing
   (5) Production
   (6) Format
   (7) Function
c. Product demand
d. Production environment
   (1) Made-to fixed specifications
   (2) Made-to-order

Provide Demonstration On:

a. Examples of production plan
b. Master production schedule
c. Basic production scheduling format

Provide Practical Application On:

a. Preparing a draft of the production plan
b. Preparing a draft of the mastser production plan

Related Instruction:

INSTRUCTIONAL MATERIALS

Textbooks:

Gunn, Computer Applications in Manufacturing

Tools and Equipment:

Personal Computer Run Time:

Demonstration: 0.5
Application: 1.5 per student

HOURS	
Classroom: 0.5	Laboratory: 2.5

EVALUATION OF PERFORMANCE

Criterion Referenced Measure:

Given a personal computer and appropriate software, the student will develop a draft of the production planning process obtaining a minimum level of ninety percent correct on all performance items.

Suggested Testing Activities and Resources:

MODULE COMPETENCY

CAMF-06 Generating a master production schedule

PERFORMANCE STATEMENT

Generate a master production schedule.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Master production schedule
   (1) Time frame
   (2) Format selection
      (a) Available balance
      (b) Backlog
      (c) Demand date
b. Role of the scheduler
   (1) Management techniques
   (2) Input data
   (3) Feedback requirements

Provide Demonstration On:

Examples of master production schedules prepared for use in industry settings

Provide Practical Application On:

Preparation of a master produce schedule
(1) Draft of schedule
(2) Computer prepared schedule

Related Instruction:

INSTRUCTIONAL MATERIALS

Textbooks:

Gunn, Computer Applications in Manufacturing

Tools and Equipment:

Personal Computer Run Time:

Demonstration: 0.5
Application: 2.0

HOURS	
Classroom: 0.5	Laboratory: 2

EVALUATION OF PERFORMANCE

Criterion Referenced Measure:

Given a personal computer and appropriate software, the student will generate a master production schedule obtaining a minimum level of ninety percent correct on all performance items.

Suggested Testing Activities and Resources:

MODULE COMPETENCY

CAMF-07 Generating capacity planning reports

PERFORMANCE STATEMENT

Generate capacity planning reports.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

Types of capacity planning
(1) Resource requirements
(2) Production capacity requirements
(3) Sequencing of production operations
    (a) Short-term
    (b) Finite versus infinite loading

Provide Demonstration On:

Examples of capacity reports and scheduling tables prepared for in-plant use

Provide Practical Application On:

a. Preparation of draft for
    (1) Typical capacity report
    (2) Infinite loading report
    (3) Finite loading report
b. Computer prepared
    (1) Typical capacity report
    (2) Infinite loading report
    (3) Finite loading report

Related Instruction:

INSTRUCTIONAL MATERIALS

Textbooks:

Gunn, Computer Applications in Manufacturing

Tools and Equipment:

Personal Computer Run Time:

Demonstration: 0.5
Application: 1.5 per student

HOURS	
Classroom: 0.5	Laboratory: 3.5

EVALUATION OF PERFORMANCE

Criterion Referenced Measure:

Given a personal computer and appropriate software, the student will generate capacity planning reports obtaining a minimum level of ninety percent correct on all performance items.

Suggested Testing Activities and Resources:

MODULE COMPETENCY

CAMF-08 Outlining shop floor control requirements

PERFORMANCE STATEMENT

Outline shop floor control requirements.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Control mechanisms
b. Priority control
c. Lead time control
d. Imput/output control
e. Sampling techniques
    (1) Production rates
    (2) Inventory level
f. Load leveling
g. Pegging
h. Shop floor status

Provide Demonstration On:

a. Computing input/output rates
b. Charting floor control
    (1) The difference graph
    (2) The cumulative graph
    (3) The difference/limits graph
    (4) The cumulative/limits graph
c. Preparing the floor control checklist

Provide Practical Application On:

a. Listing data collection methods
b. Selecting proper graph(s) to display floor conditions
c. Developing a checklist of floor control requirements

Related Instruction:

INSTRUCTIONAL MATERIALS

Textbooks:

Gunn, Computer Applications in Manufacturing

Tools and Equipment:

Personal Computer Run Time:

Demonstration: 1.0
Application: 1.5 per student

HOURS

Classroom: 0.5 Laboratory: 2

EVALUATION OF PERFORMANCE

Criterion Referenced Measure:

Given a personal computer and appropriate software, the student will outline shop floor control requirements obtaining a minimum level of ninety percent correct on all performance items.

Suggested Testing Activities and Resources:

MODULE COMPETENCY

CAMF-09 Preparing purchase order reports

PERFORMANCE STATEMENT

Prepare purchase order reports.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Open purchase order report
b. Order history report
c. Vender reports
d. Vender rating system
e. Vender qualifications
f. Financial requirements

Provide Demonstration On:

a. Open purchase order report
b. Due-in report
c. Order history report
d. Vender listing report
e. Vender rating report
f. Lead time change reporting
g. Lead time analysis report

Provide Practical Application On:

Preparing by computer-based methods the following reports
a. Open purchase order
b. Due-in
c. Order history
d. Vender listing
e. Vender rating
f. Lead time change
g. Lead time analysis

Related Instruction:

INSTRUCTIONAL MATERIALS

Textbooks:

Gunn, Computer Applications in Manufacturing

Tools and Equipment:

Personal Computer Run Time:

Demonstration: 1.0
Application: 3.0 per student

HOURS

Classroom: 0.5 Laboratory: 4

EVALUATION OF PERFORMANCE

Criterion Referenced Measure:

Given a personal computer and appropriate software, the student will prepare purchase order reports obtaining a minimum level of ninety percent correct on all performance items.

Suggested Testing Activities and Resources:

MODULE COMPETENCY

CAMF-10 Preparing data collection procedures for production forecasting

PERFORMANCE STATEMENT

Prepare data collection procedures for production forecasting.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. History of forecasting efforts associated with manufacturing
b. Computer does quantitative data analysis
c. Data over time components
   (1) Trend
   (2) Seasonality
   (3) Cyclicality
   (4) Total time series
d. Forecasting methods
e. Forecasting costs
f. Guidelines for forecasting

Provide Demonstration On:

Examples of
(1) Experimental smoothing forecasting
(2) Linear regression forecasting
(3) Multiple regression forecasting

Provide Practical Application On:

a. Stating most economic procedures for collecting data for experimental smoothing method of forecasting
b. Preparing sample chart for selected procedure

Related Instruction:

INSTRUCTIONAL MATERIALS

Textbooks:

Gunn, Computer Applications in Manufacturing

Tools and Equipment:

Personal Computer Run Time:

Demonstration: 0.5
Application: 1.5 per student

HOURS

Classroom: 1 Laboratory: 3

EVALUATION OF PERFORMANCE

Criterion Referenced Measure:

Given a personal computer and appropriate software, the student will prepare data collection procedures for production forecasting obtaining a minimum of ninety percent correct on all performance items.

Suggested Testing Activities and Resources:

MODULE COMPETENCY

CAMF-11 Recalling CAM software selection criteria

PERFORMANCE STATEMENT

Recall CAM software selection criteria.

INSTRUCTIONAL ACTIVITIES

Provide Information On;

a. The in-house designed system
   (1) What is reported
   (2) How often generated
   (3) Who will receive
   (4) Security requirements
b. Copyrighted management software packages
   (1) Advantages over in-house developed software
   (2) The cost comparison
      (a) Versus in-house
      (b) Among other copyrighted software packages
c. Criteria for selection

Provide Demonstration On:

a. An in-house system
b. Examples of copyrighted software packages

Provide Practical Application On:

a. Drafting the CAM software selection criteria
b. Preparing a checklist for selecting copyrighted software

Related Instruction:

INSTRUCTIONAL MATERIALS

Textbooks:

Gunn, Computer Applications in Manufacturing

Tools and Equipment:

Personal Computer Run Time:

Demonstration: 1.0
Appliction: 1.0 per student

HOURS

Classroom: 1 Laboratory: 4

EVALUATION OF PERFORMANCE

Criterion Referenced Measure:

Given a personal computer and appropriate software, the student will recall CAM software selection criteria obtaining a minimum of ninety percent correct on all performance items.

Suggested Testing Activities and Resources:

MODULE COMPETENCY

CAMF-12 Preparing parts codes for CAD/CAM interfaced process

PERFORMANCE STATEMENT

Prepare parts codes for CAD/CAM interfaced process.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Computer aided design (CAD)
   (1) Drafting
   (2) Analytical testing
   (3) Group technology
   (4) Process planning
b. Benefits of CAD
c. Classification and coding
   (1) Numerical and alphanumerical
   (2) Determining part characteristics
   (3) Storage and retrieval

Provide Demonstration On:

a. CAD system
b. Part classification and coding software
c. Part coding procedure

Provide Practical Application On:

a. Classifying part characteristics
b. Assigning code number to characteristics
c. Preparing a code for specific parts

Related Instruction:

INSTRUCTIONAL MATERIALS

Textbooks:

Gunn, Computer Applications in Manufacturing

Tools and Equipment:

Personal Computer Run Time:

Demonstration: 2.0
Application: 2.0 per student

HOURS

Classroom: 1 Laboratory: 4

EVALUATION OF PERFORMANCE

Criterion Referenced Measure:

Given a personal computer and appropriate software, the student will prepare parts codes for a CAD/CAM interfaced process obtaining a minimum level of ninety percent correct on all performance items.

Suggested Testing Activities and Resources:

MODULE COMPETENCY

CAMF-13 Selecting computer aided manufacturing application to meet specific production requirements

PERFORMANCE STATEMENT

Select computer aided manufacturing application to meet specific production requirements.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Domain of computer aided manufacturing
   (1) NC, CNC, and DNC machine tools
   (2) Robotics
   (3) Programmable controllers and microprocessors
   (4) Automatic storage and retrieval systems
   (5) Flexible manufacturing systems
   (6) Computer aided inspection
b. The design and manufacturing cell
   (1) Members by title/position
   (2) Members' responsibilities
   (3) Computer application for each position

Provide Demonstration On:

Tour of CAD/CAM facility

Provide Practical Application On:

For a specific product
(1) Stating members of design and engineering cell
(2) Listing members' responsibilities
(3) Selecting computer applications which are appropriate to each member's role

Related Instruction:

INSTRUCTIONAL MATERIALS

Textbooks:

Gunn, Computer Applications in Manufacturing

Tools and Equipment:

Personal Computer Run Time:

Demonstration: 0
Application: 0

HOURS

Classroom: 6 Laboratory: 0

EVALUATION OF PERFORMANCE

Criterion Referenced Measure:

Given a personal computer and appropriate software, the student will select computer aided manufacturing application to meet specific production requirements obtaining a minimum level of ninety percent correct on all performance items.

Suggested Testing Activities and Resources:

MODULE COMPETENCY

CAMF-14 Selecting, modifying and verifying computer aided manufacturing software

PERFORMANCE STATEMENT

Select, modify and verify computer aided manufacturing software.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. On-hand CAM hardware
b. On-hand systems software
   (1) In-house developed
   (2) Copyrighted software
c. References on available CAM hardware and software
d. Products which are or could be produced through CAM system

Provide Demonstration On:

Those items of system hardware and software not previously demonstrated

Provide Practical Application On:

For a specific manufacturing requirement
(1) Listing software requirements
(2) Listing software capabilities of current system
(3) Listing software programs which need modifying
(4) Listing software which must be acquired

Related Instruction:

INSTRUCTIONAL MATERIALS

Textbooks:

Gunn, Computer Applications in Manufacturing

Tools and Equipment:

Personal Computer Run Time:

Demonstration: 0.5
Application: 4.0 per student

HOURS	
Classroom: 1	Laboratory: 4.5

EVALUATION OF PERFORMANCE

Criterion Referenced Measure:

Given a personal computer and appropriate software, the student will select, modify and verify computer aided manufacturing software obtaining a minimum level of ninety percent correct on all performance items.

Suggested Testing Activities and Resources:

MODULE COMPETENCY

CAMF-15 Manufacturing a product using the computer aided manufacturing system

PERFORMANCE STATEMENT

Manufacture a product using the computer aided manufacturing system.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. CAM system to be used for this activity
b. Examples of products the system produced

Provide Demonstration On:

Those items of system hardware and software not previously demonstrated

Provide Practical Application On:

a. Stating hardware requirements
b. Stating software requirements
c. Stating material requirements
d. Stating cost factors
e. Producing the product
f. Verifying quality of product

Related Instruction:

INSTRUCTIONAL MATERIALS

Textbooks:

Gunn, Computer Applications in Manufacturing

Tools and Equipment:

Personal Computer Run Time:

Demonstration: 0.5
Application: 4.0 per student

Production Run Time:

Demonstration: 0.5
Application: 1.0 per student

HOURS	
Classroom: 0.5	Laboratory: 1

EVALUATION OF PERFORMANCE

Criterion Referenced Measure:

Given a personal computer and appropriate software, the student will manufacture a product using the computer aided manufacturing system obtaining a minimum level of ninety percent correct on all performance items.

Suggested Testing Activities and Resources:

MODULE COMPETENCY

CDMP-01 Generating the design and manufacturing requirements involving automatic measurement of a product specification

PERFORMANCE STATEMENT

Generate the design and manufacturing requirements involving automatic measurement of a product specification.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Trade and industrial use of automatic measurement
   (1) Automotive
   (2) Aviation-airframe
   (3) Aviation-engine
   (4) Electrical/electronic parts and assemblies
   (5) Food
   (6) Motors
   (7) Shoes
   (8) Textiles
   (9) Woodworking

b. Types of measurement
   (1) Volumn
   (2) Level
   (3) Temperature
   (4) Outside dimension
   (5) Inside dimension
   (6) Gauge
   (7) Weight
   (8) Pressure/vacuum
   (9) Electrical units
   (10) Chemical units

Provide Demonstration On:

Manufacturing operations, as needed, to clarify references

Provide Practical Application On:

At least two processes requiring automatic measurement

Related Instruction:

INSTRUCTIONAL MATERIALS

Textbooks:

a. Andrew and Williams, Applied Instrumentation in the Process Industries
b. Considine and Ross, Process Instruments and Control Handbook

c. Feirer, General Metals
d. Fribance, Industrial Instrumentation Fundamentals
e. Gilli, Electrical Principles for Electronics
f. Groover, Automation, Production Systems and Computer-Aided Industries
g. I.S.A., Standards and Practices for Instrumentation
h. Johnson, Manufacturing Processes
i. Johnson, Process Control Instrumentation Technology
j. Kirk and Rimboi, Instrumentation
k. Liptak, Instrument Engineers' Handbook
l. Olivo and Olivo, Fundamentals of Applied Physics
m. Pippenge and Hicks, Industrial Hydraulics
n. Stewart and Storer, Fluid Power

Tools and Equipment:

Personal Computer Run Time:

Demonstration: 0.0
Application: 4.0 per team

CAD System Run Time:

Demonstration: 0.0
Application: 4.0 per team

HOURS

Classroom: 1 Laboratory: 8

EVALUATION OF PERFORMANCE

Criterion Referenced Measure:

Given a personal computer, a CAD system and appropriate software, the team members will generate the design and manufacturing requirements involving automatic measurement of a product specification obtaining a minimum level of ninety percent correct on all performance items.

Suggested Testing Activities and Resources:

Technical report

MODULE COMPETENCY

CDMP-02 Generating the design and manufacturing requirements involved in foundry processes

PERFORMANCE STATEMENT

Generate the design and manufacturing requirements involved in foundry processes.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

Computer applications to foundry processes
(1) Materials handling
(2) Furnace control
(3) Composition control
(4) Casting operation
(5) Monitoring cooling
(6) Storage/inventory control
(7) Quality of molds

Provide Demonstration On:

Manufacturing operations, as needed, to clarify references

Provice Practical Application On:

At least two CAM applications of foundry processes

Related Instruction:

INSTRUCTIONAL MATERIALS

Textbooks:

a. Beeley, Foundry Technology
b. Cannon, How to Cast Small Metal and Rubber Parts
c. Groover, Automation, Production Systems and Computer-Aided Manufacturing
d. McCombe, Foundry Yearbook 1979
e. Simons, Dictionary of Foundry Work

Tools and Equipment:

Personal Computer Run Time:

Demonstration: 0.0
Application: 4.0 per team

CAD System Run Time:

Demonstration: 0.0
Application: 4.0 per team

HOURS

Classroom: 1 Laboratory: 8

EVALUATION OF PERFORMANCE

Criterion Referenced Measure:

Given a personal computer, a CAD system and appropriate software, the team members will generate the design and manufacturing requirements involved in foundry processes obtaining a minimum level of ninety percent correct on all performance items.

Suggested Testing Activities and Resources:

Technical report

MODULE COMPETENCY

CDMP-03 Generating the design and manufacturing requirements involved in hot-forming metal

PERFORMANCE STATEMENT

Generate the design and manufacturing requirements involved in hot-forming metal.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

Computer applications for the hot-forming process
(1) Materials handling
(2) Sizing of cold stock
(3) Control of heat
(4) Hot-forming
    (a) Pull
    (b) Stress
    (c) Twist
    (d) Bend
(5) Temper
(6) Quality check
(7) Storage

Provide Demonstration On:

Manufacturing operation, as needed, to clarify other references

Provide Practical Application:

At least two CAM applications for hot-formed metal

Related Instruction:

INSTRUCTIONAL MATERIALS

Textbooks:

a. Avitzur, Metal Forming: Processes and Analysis
b. Blandford, The Practical Handbook of Black Smithing and Metalworking
c. Groover, Automating Production Systems and Computer-Aided Manufacturing

Textbooks (Continued):

d. Read, Automation in the Metal Finishing Industry
e. Rykalin, Laser Machining and Welding
f. Society of Manufacturing Engineers, Tools and Manufacturing Engineers' Handbook

Tools and Equipment:

Personal Computer Run Time:

Demonstration: 0.0
Application: 4.0 per team

CAD System Run Time:

Demonstration: 0.0
Application: 4.0 per team

HOURS

Classroom: 1 Laboratory: 8

EVALUATION OF PERFORMANCE

Criterion Referenced Measure:

Given a personal computer, a CAD system and appropriate software, the team members will generate the design and manufacturing requirements involved in hot-forming metal obtaining a minimum level of ninety percent on all performance items.

Suggested Testing Activites and Resources:

Technical report

MODULE COMPETENCY

CDMP-04 Generating the design and manufacturing requirements involved in cold-forming metal

PERFORMANCE STATEMENT

Generate the design and manufacturing requirements involved in cold-forming metal.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

Computer applications for the cold-forming process
(1) Materials handling
(2) Sizing of stock
(3) Strength of materials
(4) Cold-forming
    (a) Stamp
    (b) Twist
    (c) Bend
(5) Quality check
(6) Storage/inventory control

Provide Demonstration On:

Manufacturing operations, as needed, to clarify references

Provide Practical Application On:

At least two CAM applications for cold-formed metal

Related Instruction:

INSTRUCTIONAL MATERIALS

Textbooks:

a. Avitzur, Metal Forming: Processes and Anlyses
b. Groover, Automation, Production Systems and Computer-Aided Manufacturing
c. Read, Automation in the Metal Finishing Industry
d. Society of Manufacturing Engineers, Tool and Manufacturing Engineers' Handbook

Tools and Equipment:

Personal Computer Run Time:

Demonstration: 0.0
Application: 4.0 per team

CAD System Run Time:

Demonstration: 0.0
Application: 4.0 per team

HOURS

Classroom: 1 Laboratory: 8

EVALUATION OF PERFORMANCE

Criterion Referenced Measure:

Given a personal computer, a CAD system and appropriate software, the team members will generate the design and manufacturing requirements involved in cold-forming metal obtaining a minimum level of ninety percent correct on all performance items.

Suggested Testing Activities and Resources:

Technical report

MODULE COMPETENCY

CDMP-05 Generating the design and manufacturing requirements involved in shaping metal with machine tools and turning machines

PERFORMANCE STATEMENT

Generate the design and manufacturing requirements involved in shaping metal with machine tools and turning machines.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

Computer applications for lathe process
(1) Materials handling
(2) Sizing of stock
(3) Programming requirments
    (a) NC
    (b) CNC
    (c) DNC
(4) Quality check
(5) Storage/inventory control

Provide Demonstration On:

Manufacturing operations, as needed, to clarify references

Provide Practical Application On:

At least two CAM applications for metal shaping with turning machines

Related Instruction:

INSTRUCTIONAL MATERIALS

Textbooks:

a. Avitzur, Metal Forming
b. Groover, Automation, Production Systems and Computer-Aided Manufacturing
c. Pressman and Williams, Numerical Control and Computer-Aided Manufacturing
d. Read, Automation in the Metal Finishing Industry
e. Society of Manufacturing Engineers, Tool and Manufacturing Engineers' Handbook

Tools and Equipment:

Personal Computer Run Time:

Demonstration: 0.0
Application: 4.0 per team

CAD System Run Time:

Demonstration: 0.0
Application: 4.0 per team

HOURS

Classroom: 1 Laboratory: 8

EVALUATION OF PERFORMANCE

Criterion Referenced Measure:

Given a personal computer, a CAD system and appropriate software, the team members will generate the design and manufacturing requirements involved in shaping metal with machine tools and turning machines obtaining a minimum level of ninety percent correct on all performance items.

Suggested Testing Activities and Resources:

Technical report

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MODULE COMPETENCY

CDMP-06 Generating the design and manufacturing requirements involved in producing cylindrical holes in metal with computer controlled drilling machine

PERFORMANCE STATEMENT

Generate the design and manufacturing requirements involved in producing cylindrical holes in metal with computer controlled drilling machine.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

Computer applications for drilling machine processes
(1) Materials handling
(2) Sizing of stock
(3) Programming requirements
    (a) NC
    (b) CNC
    (c) DNC
(4) Quality check
(5) Storage/inventory control

Provide Demonstration On:

Manufacturing operations, as needed, to clarify references

Provide Practical Application On:

At least two CAM applications for producing cylindrical holes in metal

Related Instruction:

INSTRUCTIONAL MATERIALS

Textbooks:

a. Avitzur, Metal Forming
b. Groover, Automation, Production Systems and Computer-Aided Manufacturing
c. Pressman and Williams, Numerical Control and Computer-Aided Manufacturing
d. Read, Automation in the Metal Finishing Industry
e. Society of Manufacturing Engineers, Tool and Manufacturing Engineers' Handbook

Tools and Equipment:

Personal Computer Run Time:

Demonstration: 0.0
Application: 4.0 per team

CAD System Run Time:

Demonstration: 0.0
Application: 4.0 per team

HOURS

Classroom: 1 Laboratory: 8

EVALUATION OF PERFORMANCE

Criterion Referenced Measure:

Given a personal computer, a CAD system and appropriate software, the team will generate the design and manufacturing requirements involved in producing cylindrical holes in metal with computer controlled drilling machine obtaining a minimum level of ninety percent correct on all performance items.

Suggested Testing Activities and Resources:

Technical report

MODULE COMPETENCY

CDMP-07 Generating the design and manufacturing requirements involved in shaping and planing metal with a computer controlled shaper machine

PERFORMANCE STATEMENT

Generate the design and manufacturing requirements involved in shaping and planing metal with a computer controlled shaper machine.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

Computer applications for shaper processes
(1) Materials handling
(2) Sizing of stock
(3) Programming requirements
    (a) NC
    (b) CNC
    (c) DNC
(4) Quality circle
(5) Storage/inventory control

Provide Demonstration On:

Manufacturing operations, as needed, to clarify references

Provide Practical Application On:

At least two CAM applications for shaping and planing metal.

Related Instruction:

INSTRUCTIONAL MATERIALS

Textbooks:

a. Avitzur, Metal Forming
b. Groover, Automation, Production Systems and Computer-Aided Manufacturing
c. Pressman and Williams, Numerical Control and Computer-Aided Manufacturing
d. Read, Automation in the Metal Finishing Industry
e. Society of Manufacturing Engineers, Tool and Manufacturing Engineers' Handbook

Tools and Equipment:

Personal Computer Run Time:

Demonstration: 0.0
Application: 4.0 per team

CAM System Run Time:

Demonstration: 0.0
Application: 4.0 per team

HOURS

Classroom: 1 Laboratory: 8

EVALUATION OF PERFORMANCE

Criterion Referenced Measure:

Given a personal computer, a CAD system and appropriate software, the team will generate the design and manufacturing requirements involved in shaping and planing metal with a computer controlled shaper machine obtaining a minimum level of ninety percent correct on all performance items.

Suggested Testing Activities and Resources:

Technical report

MODULE COMPETENCY

CDMP-08 Generating the design and manufacturing requirements involved in milling metal with a computer controlled milling machine

PERFORMANCE STATEMENT

Generate the design and manufacturing requirements involved in milling metal with a computer controlled milling machine.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

Computer applications for milling machine processes
(1) Materials handling
(2) Sizing of stock
(3) Programming requirements
    (a) NC
    (b) CNC
    (c) DNC
(4) Quality check
(5) Storage/inventory control

Provide Demonstration On:

Manufacturing operations, as needed, to clarify references

Provide Practical Application On:

At least two CAM applictions for milling metal

Related Instruction:

INSTRUCTIONAL MATERIALS

Textbooks:

a. Avitzur, Metal Forming
b. Groover, Automation, Production Systems and Computer-Aided Manufacturing
c. Pressman and Williams, Numerical Control and Computer-Aided Manufacturing
d. Read, Automation in the Metal Finishing Industry
e. Society of Manufacturing Engineers, Tool and Manufacturing Engineers' Handbook

Tools and Equipment:

Personal Computer Run Time:

Demonstration: 0.0
Application: 4.0 per team

CAD System Run Time:

Demonstration: 0.0
Application: 4.0 per team

HOURS

Classroom: 1 Laboratory: 8

EVALUATION OF PERFORMANCE

Criterion Referenced Measure:

Given a personal computer, a CAD system and appropriate software, the team members will generate the design and manufacturing requirements involved in milling metal with a computer controlled milling machine obtaining a minimum level of ninety percent correct on all performance items.

Suggested Testing Activities and Resources:

Technical report

MODULE COMPETENCY

CDMP-09 Generating the design and manufacturing requirements involved in producing plastic products with computer controlled processes

PERFORMANCE STATEMENT

Generate the design and manufacturing requirements involved in producing plastic products with computer controlled processes.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Categories of use
   (1) Building
   (2) Consumable products
   (3) Medicine
   (4) Packaging
   (5) Plumbing
   (6) Surgery
b. Type of production process
   (1) Molding
   (2) Hot-forming
   (3) Turning
   (4) Dilling
   (5) Shaping and planing
   (6) Milling
c. Computer applications for producing plastic products
   (1) Materials handling
   (2) Sizing of stock
   (3) Programming requirements
      (a) NC
      (b) CNC
      (c) DNC
   (4) Quality check
   (5) Storage/inventory control

Provide Demonstration On:

Manufacturing operations, as needed, to clarify references

Provide Practical Application On:

At least two CAM applications for producing plastic products

Related Instruction:

INSTRUCTIONAL MATERIALS

Textbooks:

a. ASTM, Annual Book of ASTM Standards: Plastics-General Test Methods, Nomenclature
b. ASTM, Annual Book of ASTM Standards: Plastics-Material Film, Reinforced and Cellular Plastics
c. Groover, Automation, Production Systems and Computer-Aided Manufacturing
d. Miller, Plastics Products Design Handbook

Tools and Equipment:

Personal Computer Run Time:

Demonstration: 0.0
Application: 4.0 per team

CAD System Run Time:

Demonstration: 0.0
Application: 4.0 per team

HOURS

Classroom: 1 Laboratory: 8

EVALUATION OF PERFORMANCE

Criterion Referenced Measure:

Given a personal computer, a CAD system and appropriate software, the team members will generate the design and manufacturing requirements involved in producing plastic products with computer controlled processes obtaining a minimum level of ninety percent correct on all performance items.

Suggested Testing Activities and Resources:

Technical report

MODULE COMPETENCY

CDMP-10 Generating the design and manufacturing requirements involved in producing electrical/electronic parts and assemblies with computer controlled processes

PERFORMANCE STATEMENT

Generate the design and manufacturing requirements involved in producing electrical/electronic parts and assemblies with computer controlled processes.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Categories of electric/electronic product use
   (1) Appliance
   (2) Communication
   (3) Defense
   (4) Environmental control
   (5) Manufacturing processes
   (6) Medical
b. Type of production process
   (1) Casting
   (2) Ceramic
   (3) Plastic
   (4) Plating/etching
   (5) Machining
   (6) Winding (other than motors)
   (7) Drawing (wire)
c. Computer applications for producing electrical/electronic parts and assemblies
   (1) Materials handling
   (2) Vendor supplied material
   (3) Programming requirements
      (a) NC
      (b) CNC
      (c) DNC
   (4) Quality check
   (5) Storage/inventory control

Provide Demonstration On:

Manufacturing operations, as needed, to clarify references

Provide Practical Application On:

At least two CAM applications for producing electrical/electronic parts and assemblies

Related Instruction:

INSTRUCTIONAL MATERIALS

Textbooks:

a. Gregor, Manufacturing Processes: Ceramics
b. Groover, Automation, Production Systems and Computer-Aided Manufacturing
c. Matisoff, Handbook for Electronics Manufacturing Engineering

Tools and Equipment:

Personal Computer Run Time:

Demonstration: 0.0
Application: 4.0 per team

CAM System Run Time:

Demonstration: 0.0
Application: 4.0 per team

HOURS

Classroom: 1 Laboratory: 8

EVALUATION OF PERFORMANCE

Criterion Referenced Measure:

Given a personal computer, a CAD system and appropriate software, the team members will generate the design and manufacturing requirements involved in producing electric/electronic parts and assemblies with computer controlled processes obtaining a minimum level of ninety percent correct on all performance items.

Suggested Testing Activities and Resources:

Technical report

MODULE COMPETENCY

CDMP-11 Generating the design and manufacturing requirements involved in packaging food with computer controlled processes

PERFORMANCE STATEMENT

Generate the design and manufacturing requirements involved in packaging food with computer controlled processes.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Types of packaging used in processing food
   (1) Canned
   (2) Bottled
   (3) Boxed
   (4) Crated
   (5) Frozen
   (6) Freeze-dried
b. Computer applications for processing foods
   (1) Materials handling
   (2) Grading/selection system
   (3) Vendor supplied materials
   (4) Hygiene
   (5) Programming requirements
   (6) Inspection
   (7) Storage/inventory control

Provide Demonstration On:

Manufacturing operations, as needed, to clarify references

Provide Practical Application On:

At least two CAM applications for packaging food products

Related Instruction:

INSTRUCTIONAL MATERIALS

Textbooks:

a. Doyle and Miller, Control of Critical Points in Food Processing

Textbooks (Continued):

b. Groover, Automation, Production Systems and Computer-Aided Manufacturing
c. Heldman and Singh, Food Process Engineering
d. Jowitt, Hygenic Design and Operation of Food Plant
e. Powers, Basics of Quality Food Production
f. Toledo, Fundamentals of Food Process Engineering
g. Woodroof and Luh, Commercial Fruit Processing

Tools and Equipment:

Personal Computer Run Time:

Demonstration: 0.0
Application: 4.0 per team

CAD System Run Time:

Demonstration: 0.0
Application: 4.0 per team

HOURS

Classroom: 1 Laboratory: 8

EVALUATION OF PERFORMANCE

Criterion Referenced Measure:

Given a personal computer, a CAD system and appropriate software, the team members will generate the design and manufacturing requirements involved in packaging food with computer controlled processes obtaining a minimum level of ninety percent correct on all performance items.

Suggested Testing Activities and Resources:

Technical report

MODULE COMPETENCY

CDMP-12 Generating the design and manufacturing requirements involved in producing electric motors/ generators with computer controlled processes

PERFORMANCE STATEMENT

Generate the design and manufacturing requirements involved in producing electric motors/generators with computer controlled processes.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Categories of electrical motor/genertor uses
   (1) Appliances
   (2) Communication
   (3) Defense
   (4) Environmental control
   (5) Manufacturing processes
   (6) Medical
   (7) Power production
   (8) Transportation
b. Type of production process
   (1) Casting
   (2) Ceramic
   (3) Plastic
   (4) Plating/etching
   (5) Machining
   (6) Winding
c. Computer applications for producing electric motors
   (1) Materials handling
   (2) Vendor supplied materials
   (3) Programming requirements
      (a) NC
      (b) CNC
      (c) DNC
   (4) Quality check
   (5) Storage/inventory control

Provide Demonstration On:

Manufacturing operations, as needed, to clarify references

Provide Practical Application On:

At least two CAM applications for producing electric motors/ generators

Related Instruction:

INSTRUCTIONAL MATERIALS

Textbooks:

a. Groover, Automation, Production Systems and Computer-Aided Manufacturing
b. Matisoff, Handbook of Electronics Manufacturing Engineering
c. Richardson, Handbook of Rotating Electric Machinery

Tools and Equipment:

Personal Computer Run Time:

Demonstration: 0.0
Application: 4.0 per team

CAD System Run Time:

Demonstration: 0.0
Application: 4.0 per team

HOURS

Classroom: 1 Laboratory: 8

EVALUATION OF PERFORMANCE

Criterion Referenced Measure:

Given a personal computer, a CAD system and appropriate software, the team members will generate the design and manufacturing requirements involved in producing electric motors/generators with computer controlled processes obtaining a minimum level of ninety percent correct on all performance items.

Suggested Testing Activities and Resources:

Technical report

MODULE COMPETENCY

CDMP-13 Generating the design and manufacturing requirements involved in producing shoes and leatherwork with computer controlled processes

PERFORMANCE STATEMENT

Generate the design and manufacturing requirements involved in producing shoes and leatherwork with computer controlled processes.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Categories of products
    (1) Shoes from
        (a) Leather
        (b) Man-made materials
    (2) Accessories from
        (a) Leather
        (b) Man-made materials
b. Type of production processes
    (1) Heat formed/fused
    (2) Sewing
    (3) Cutting
    (4) Stamping
    (5) Chemical treatment
    (6) Riveting
    (7) Casting
c. Computer applications for producing shoes and leather goods
    (1) Materials handling
    (2) Vendor supplied materials
    (3) Programming requirements
    (4) Quality checks
    (5) Storage/inventory control

Provide Demonstration On:

Manufacturing operations, as needed, to clarify references

Provide Practical Application On:

At least two CAM applications for producing shoes and leather goods

Related Instruction:

INSTRUCTIONAL MATERIALS

Textbooks:

a. O'Flaherty, The Chemistry and Technology of Leather
b. Groover, Automation, Production Systems and Computer-Aided Manufacturing

Tools and Equipment:

Personal Computer Run Time:

Demonstration: 0.0
Application: 4.0 per team

CAD System Run Time:

Demonstration: 0.0
Application: 4.0 per team

HOURS

Classroom: 1 Laboratory: 8

EVALUATION OF PERFORMANCE

Criterion Referenced Measure:

Given a personal computer, a CAD system and appropriate software, the team members will generate the design and manufacturing requirements involved in producing shoes and leatherwork with computer controlled processes obtaining a minimum level of ninety percent correct on all performance items.

Suggested Testing Activities and Resources:

Technical report

MODULE COMPETENCY

CDMP-14 Generating the design and manufacturing requirements involved in producing textile products with computer controlled processes

PERFORMANCE STATEMENT

Generate the design and manufacturing requirements involved in producing textile products with computer controlled processes.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Categories of products
    (1) Clothing
    (2) Housewares
    (3) Carpet
    (4) Furnishings
        (a) Home
        (b) Commercial
b. Types of production processes
    (1) Cleaning
    (2) Spinning
    (3) Weaving
    (4) Knitting
    (5) Dying
    (6) Printing
    (7) Cutting
    (8) Sewing
c. Computer applications for producing textile products
    (1) Materials handling
    (2) Vendor supplied materials
    (3) Programming requirements
    (4) Quality checks
    (5) Storage/inventory control

Related Instruction:

INSTRUCTIONAL MATERIALS

Textbooks:

a. Enrick, Industrial Engineering Manual: For the Textile Industry
b. Groover, Automation, Production Systems and Computer-Aided Manufacturing
c. Ormerod, Management of Textile Production
d. Palmer, Textile Processing and Finishing Aids: Recent Advances

Tools and Equipment:

Personal Computer Run Time:

Demonstration: 0.0
Application: 4.0 per team

CAD System Run Time:

Demonstration: 0.0
Application: 4.0 per team

HOURS

Classroom: 1 Laboratory: 8

EVALUATION OF PERFORMANCE

Criterion Referenced Measure:

Given a personal computer, a CAD system and appropriate software, the team members will generate the design and manufacturing requirements involved in producing textile products with computer controlled processes obtaining a minimum level of ninety percent correct on all performance items.

Suggested Testing Activities and Resources:

Technical report

MODULE COMPETENCY

CDMP-15 Generating the design and manufacturing requirements involved in producing wood and wood-based products with computer controlled processes

PERFORMANCE STATEMENT

Generate the design and manufacturing requirements involved in producing wood and wood-based products with computer controlled processes.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Wood industry production processes
    (1) Selecting timber
    (2) Rough cut
    (3) Aging
    (4) Sizing
    (5) Grading
    (6) By product
b. Wood products/uses
    (1) Construction
    (2) Furnishings
        (a) Home
        (b) Commercial
    (3) Pulp-based
        (a) Paper
        (b) Cardboard
        (c) Fiber
c. Computer applications for producing wood and wood-based products
    (1) Materials handling
    (2) Vendor supplied materials
    (3) Programming requirements
    (4) Quality checks
    (5) Storage/inventory control

Related Instruction:

INSTRUCTIONAL MATERIALS

Textbooks:

a. Benn Directories Service, Woodworking Industry Buyers Guide

Textbooks (Continued):

b. Clark, Engineering Woodworking
c. Clark, Pulp Technology and Treatment for Paper
d. Feirer, Woodworking for Industry: Technology and Practice
e. Groover, Automation, Production Systems and Computer-Aided Manufacturing
f. Miller Freeman Publishers, Pulping Processes, Mill Operations, Technology and Practices

Tools and Equipment:

Personal Computer Run Time:

Demonstration: 0.0
Application: 4.0 per team

CAD System Run Time:

Demonstration: 0.0
Application: 4.0 per team

HOURS

Classroom: 1 Laboratory: 8

EVALUATION OF PERFORMANCE

Criterion Referenced Measure:

Given a personal computer, a CAD system and appropriate software, the team members will generate the design and manufacturing requirements involved in producing wood and wood-based products with computer controlled processes obtaining a minimum level of ninety percent correct on all performance items.

Suggested Testing Activities and Resources:

Technical report

SECTION V

INSTRUCTIONAL MATERIAL

Textbooks and Wookbooks:

Andrew, William, G. and Williams, H.B., Applied Instrumentation in the Process Industri... Houston, TX: Gulf Publishing Company, 1980.

Angell, Ian O., A Practical Introduction to Computer Graphics. New York, NY: John Wiley and Sons, Inc., 1981.

ASTM, Annual Book of ASTM Standards, 1981: Plastics-General Test Methods, Nomenclature. Philadelphia, PA: American Society for Testing and Materials, 1981.

ASTM, Annual Book of ASTM Standards: Plastics-Material Film, Reinforced and Cellular Plastics. Philadelphia, PA: American Society for Testing and Materials, 1981.

Avitzur, Metal Forming. New York, NY: Dekker, Marcel, Inc., 1980.

Beeley, P.R., Foundry Technology. Woburn, MA: Butterworth Publishing Inc., 1972.

Benn Directories Service, Woodworking Industry Buyers Guide. New York, NY: Nichols Publishing Company, 1979.

Blandford, Percy W., The Practical Handbook of Blacksmithing and Metalworking. Blue Ridge Summit, PA: Tab Books, Inc.

Cannon, Bill, How to Cast Small Metal and Rubber Parts. Blue Ridge Summit, PA: Tab Books Inc., 1979.

Clark, J., et al., Engineering Woodworking, Vol. 1, 2nd ed. Philadelphia, PA: International Ideas Inc., 1975.

Clark, James d'A., Pulp Technology and Treatment for Paper. San Francisco, CA: Miller Freeman Publishers Inc., 1978.

Considine. Douglas M. and Ross, S.D., Process Instruments and Control Handbook. New York, NY: Gregg/McGraw-Hill Book Company, 1974.

Doyle, Edwin S. and Miller, Abe, eds., Control of Critical Points in Food Processing: A Systems Approach. Washington, D.C.: The Food Processors Institute, 1977.

Enrich, Norbert L., Industrial Engineering Manual: for the Texting Industry 2nd ed. Melborne, FL: Robert E. Krieger Publishing Company, 1978.

Feirer, John L., General Metals rev. 5ed. New York, NY: McGraw-Hill Book Company, 1980.

Feirer, John L., Woodworking for Industry: Technology and Practice. New York, NY Charles Scribner's Sons, 1979.

Foley, James D., Fundamentals of Interactive Computer Graphics. Philippines: Addison-Wesley Publishing Company, Inc., 1982.

Fribance, Austin E., Industrial Instrumentation Fundamentals. New York, NY McGraw-Hill Book Company, 1962.

Gilli, Angelo C., Sr., Electrical Principles for Electronics. New York, NY McGraw-Hill Book Company, 1977.

Goetsch, David L., The CAD/CAM Workbook. Cincinnati, OH: South-Western Publishing Company, 1983.

Gregor, T., Manufacturing Processes: Ceramics. Englewood Cliffs, NJ: Prentice-Hall, 1976.

Groover, Mikell P., Automation Production Systems and Computer-Aided Manufacturing. Englewood Cliffs, NJ: Prentice-Hall, 1980.

Gunn, Thomas, G., Computer Applications in Manufacturing. New York, NY: Industrial Press Inc., 1981.

Heldman D.R. and Singh, R.P., Food Process Engineering, 2nd ed. Westport, CT: AVI Publishing Company, 1981.

ISA, Standards and Practices for Instrumentation. Research Triangle Park, NC: Instrument Society of America, 1980.

Johnson, Curtis D., Process Control Instrumentation Technology, 2nd ed. New York, NY: John Wiley and Sons, 1982.

Johnson, Harold V., Manufacturing Processes. Peoria, IL: Bennett Publishing Company, 1979.

Jowitt, R., ed., Hygenic Design and Operation of Food Plant. Westport, CT: AVI Publishing Company, Inc., 1980.

Kirk, Franklin W. and Rimboi, Nicholas R., Instrumentation, 3rd ed. Chicago, IL: American Tech, 1974.

Liptak, Beta G., ed., Instrument Engineer's Handbook. Radnor, PA: Chilton Book Company, 1962-1972.

Matisoff, Bernard S., Handbook of Electronics Manufacturing Engineering. New York, NY: Van Ness Reinhold Company, 1978.

Miller, Plastics Products Design Handbook Part A. New York, NY: Dekker, Marcel, Inc., 1981.

Miller Freeman Publishers, Pulping Processes: Mill Operations, Technology and Practices. San Francisco, CA: Miller Freeman Publishers, Inc., 1981.

McCombe, C., ed., Foundry Year Book 1979. New York, NY: International Publishing Service, 1979.

O'Flaherty, Fred, et al., eds., The Chemistry and Technology of Leather. Melbourne, FL: Robert E. Krieger Publishing Company, 1978.

Olivio, C. Thomas and Olivio, Thomas P., Fundamentals of Applied Physics. Albany, NY: Delmar Publishers, 1978.

Ormerod, A., Management of Textile Production. Woburn, MA: Butterworth Publishing Inc., 1979.

Palmer, J.W., Textile Processing and Finishing Aids: Recent Advances. Park Ridge, NJ: Noyes Data Corp., 1978.

Pippenger, John H. and Hicks, Taylor G., Industrial Hydraulics. New York, NY: McGraw-Hill Book Company, 1979.

Powers, Jo Marie, Basics of Quality Food Production. New York, NY: John Wiley and Sons, 1979.

Pressman, R.S. and Williams, J.E., Numerical Control and Computer-Aided Manufacturing. New York, NY: John Wiley and Son, 1977.

Read, R.R., ed., Automation in the Metal Finishing Industry. New York, NY: International Publishing Service, 1976.

Richardson, Donald V., ed., Handbook of Rotating Electric Machinery. Reston, VA: Reston Publishing Company, Inc., 1978.

Ryan, Daniel L., Computer Graphics Problem Manual. Monterey, CA: Brooks/Cole Engineering Division, 1983.

Rykalan, N., et al., Laser Machining and Welding. Elmsford, NY: Pergamon Press, Inc., 1979.

Scott, Joan E., Introduction to Interactive Computer Graphics. New York, NY: John Wiley and Son, Inc., 1982.

Simons, E.N., Dictionary of Foundry Work. Woodstock, NY: Beekman Publisners Inc., 1972.

Society of Manufacturing Engineers, Tool and Manufacturing Engineers Handbook. New York, NY: McGraw-Hill Book Company, 1976.

Stewart, Harry L. and Storer, John M., Fluid Power. Indianapolis, IN: Bobbs-Merrill Educational Publishing Company, 1980.

The National Center for Research in Vocational Education, CAD/CAM Programs, Columbus, OH: The Ohio State University, 1983.

Toledo, Romeo T., Fundamentals of Food Process Engineering. Westport, CT: AVI Publishing Company, Inc., 1980.

Voisinet, Donald, Introduction to CAD. New York, NY: McGraw-Hill, 1983.

Woodroof, J.G. and Luh, B.S., Commercial Fruit Processing. Westport, CT: AVI Publishing Company, Inc., 1975.

Audiovisuals:

Bergwall, COMPUTER AIDED DESIGN EXPLAINED, Compete program includes: three color filmstrips with three cassettes (12-16 minute each) Study Guide.

1. Initiating the Design

   * Components of unigraphics system
   * Operation of program function keyboard
     * menu monitor
     * cathrode ray tube
     * keyboard
     * How to "Log On" system to design mechanical part
     * Sequence required to establish points, lines, arcs on preliminary drawing

2. Developing the Design

   * How to establish other points from absolute coordination point, lines tangent to curves, centerline construction, circles and angles, trimming of lines
   * How to make deletions

3. Deminsioning the Design

   * How to establish horizontal and vertical linear dimensions
   * Sequences required for outslide, inside diameter, radii
   * Use of alternate action to establish alignment with existing dimensions
   * Parameters for leader notation arrow direction

DMR Associates, CAD/CAM Basics. A full-color 35mm. slide/print program for secondary and post-secondary technical education curricula.

An Overview of CAD/CAM Technology:

* 80 full-color slides
* Diagrams of major CAD/CAM concepts such as the single, interactive database; networking; the design-manufacturing continuum, and others
* CAD design elements including basic geometry, dimensions, 3-D surfaces, toolpaths, and solid models
* Keys to the users productivity on CAD/CAM systems, and how the systems are used
* CAD/CAM hardware. Components of the typical system
* The design through manufacturing sequence portrayed on a single part

* Robots and numerically controlled macnines, and their place in CAD/CAM
* Plus dozens of actual screen photographs of computer models covering applications in mechanical and electrical design, mapping and architecture
* Seventy page Presenter's Guide containing background information
* Participating suppliers include Computervision, G.E. Clama, Schlumberger-Applicon, Intergraph, MCS, Kearney-Trucker, Apollo Computer, Racal-Redac, Via Systems

South-Western Publishing Company. The CAD/CAM SOUND FILM-STRIPS. Four filmstrips and cassettes expanded on the material presented in the CAD/CAM Workbook by Goetsch. Concentrates on: concepts, systems and application of computer-aided drafting and computer-aided manufacturing.

Resource Addresses:

Addison-Wesley Publishing Company, Inc.
120 Interstate North Parkway, E.
Atlanta, GA 30339

ASTM
American Society for Testing and Materials
1916 Race Street
Philadelphia, PA 19103

American Tech
5608 Stony Island Avenue
Chicago, IL 60637

AVI Publishing Company, Inc.
250 Post Road, E.
P. O. Box 831
Westport, CT 06881

Beekman Publishers, Inc.
Rt. 1, Box 506
Woodstock, NY 12498

Bennett Publishing Company
809 W. Detweiller Drive
Department E 81
Peoria, IL 61615

Bergwall
P. O. Box 238
Garden City, NY 11530

Bobbs-Merrill Educational Publishing
4300 West 62nd Street
P. O. Box 7080
Indianapolis, IN 46202

Brooks/Cole Engineering Division
555 Abrego Street
Monterey, CA 93940

Butterworth Publishing Inc.
10 Tower Office Park
Woburn, MA 01801

Charles Scribner's Sons
597 Fifth Avenue
New York, NY 10017

Chilton Book Company
Chilton Way
Radnor, PA 19089

Dekker Marcel, Inc.
270 Madison Avenue
New York, NY 10016

Delmar Publishers
National Sales Office
50 Wolf Road
Albany, NY 12205

DMR Associates
Box 255
West Groton, MA 01472

Gregg/McGraw-Hill
1221 Avenue or the Americas
New York, NY 10020

Gulf Publishing Company
P. O. Box 2608
Houston, TX 77001

International Ideas, Inc.
1627 Spruce Street
Philadelphia, PA 19103

International Publishing Service
114 E. 32nd Street
New York, NY 10016

ISA
Instrument Society of America
67 Alexander Drive
P. O. Box 1227
Research Triangle Park, NC 27709

John Wiley and Sons
605 Third Avenue
New York, NY 10158

Robert E. Krieger Publishing Company
P. O. Box 9542
Melbourne, FL 32901

McGraw-Hill Book Company
330 West 42nd Street
New York, NY 10036

Miller Freeman
Publictions, Inc.
500 Howard Street
San Francisco, CA

Nichols Publishing Company
P. O. Box 96
New York, NY 10024

Noyes Data Corporation
Mill Road at Grand Avenue
Park Ridge, NJ 07656

Pergamon Press, Inc.
Maxwell House, Fairview Park
Elmsford, NY 10523

Prentice-Hall
Englewood Cliffs, NJ 07632

Reston Publishing Company,
Inc.
11480 Sunset Hills Road
Reston, VA 22090

South-Western Publishing
Company
5101 Madison Road
Cincinnati, OH 45227

Tab Books, Inc.
Blue Ridge Summit, PA 17214

The Food Processors Institute
1133 20th Street, NW
Washington, DC 20036

The National Center for
Research in Vocational
Education
The Ohio State University
1960 Kenny Road
Columbus, OH 43210

Van Nos Reinhold Company
Division of Litton Educational
Publishing Inc.
135 W. 50th Street
New York, NY 10020

EQUIPMENT LIST

Equipment List Preparation

Developing a realistic equipment list is very much a local requirement. Many factors are involved, and each weighted differently when compaired with listings of another local. Aiming for "the best our money can buy" may be too limiting if our does not include shared cost from local firms, educational foundations or computer firm educational funds. When a local firm is using a particular system and is willing to assist in underwriting part of the cost of acquisition for that system, then such a buy decision is "best" for the community. Where two or more firms are operating different systems then the community interest may be served better if a mix of different systems is established in the educational setting. The beginning step for list preparation is to investigate and identify funds available at the local, state and national levels.

Managing CAD/CAM equipment for the educational setting is similar to that of any firm. For this reason the instructor should become knowledgeable of what systems are available, their advantages and disadvantages, space requirements, operational and maintenance cost, and the cost of support equipment and supplies. These are management concerns presented by Scott, in chapter ten, "Management Concerns," of Introduction to Interaction Computer Graphics. She presents such topics as:

1. Application Characteristics
2. Turnkey System Selection

3. Personnel and Procedures
4. Economic Justification
5. Graphics Information Source List
    a. Bibliography
    b. Books
    c. Periodicals and Other Publications
    d. Short Courses
    e. Conventions and Exhibitions

(Scott, 189-230)

Those same topics may be used by the instructor to establish a file on equipment and related course support materials. Voisinet and Gunn also present equipment reviews in their textbooks. A review of all three references will present the reader with the major factors to be considered in establishing an equipment list.

Equipment for Introduction to CAD

All of the modules in this course may be completed on a two dimensional drawing system. However, for demonstration purposes it is suggested that the first CAD system purchased have three dimensional drawing capability. When all four CAD/CAM courses are offered the equipment buy decision must include the total support requirements.

Approximately one-fourth of each students' total course hours will be spent at the CAD system. At least one-fourth of the available course hours will be used by the instructor in demonstrating CAD system operation. These factors are used in developing the following requirements table.

Factor	Number of CAD Systems Line Total	Cumulative
Instructor with two students	1	1
Instructor with six students	1	2
Instructor with ten students	1	3
Instructor with fourteen students	1	4
Instructor with eighteen students	1	5

Requirements Table - Introduction to CAD

Equipment for CAD Applications

Approximately 90% of each students available hours will be taken up with CAD system operation time. One-third of the modules require a CAD system having three dimensional capability. The minimum requirement for this course is one CAD system per student with one-third the total having three dimensional capability. For ease of availability to three dimensional systems, it is suggested that half the systems have three dimensional capability. Module six involves the use of special modification features and should be supported by a CAD system having modeling capability.

Factor	Condition	Number of CAD Systems Line	Cumulative
Student-1	3-D with modeling capability	1	1
Students-2	2-D	1	2
Students-3	3-D without modeling	1	3
Students-4	2-D	1	4
Odd n	3-D without modeling	1	odd n
Even n	2-D	1	even n

Requirements Table - CAD Applications

Computer Aided Manufacturing

Approximately 50% of each student control time will be taken up with operating a personal computer. Module 15 also

requires a computer controlled production capability. This requirement may be met with an NC, CNC or DNC system.

Factor	Description	Number of Systems Line	Cumulative
Student-1	personal computer	1	1
Students-2		0	1
Students-n	personal computer		½ n

Requirements Table - CAM

CAD/CAM Problems

This course groups design and production students into paired teams. It is estimated that 90% of a team's available hours will be taken up with computer operations. The design team member will require a CAD system and the production team member will require a personal computer. It is suggested that half of the CAD systems have 3-D capability and that at least one of those have modeling capability.

Team	Factor	Description	Number of Systems Line	Cumulative
1	Design student	3-D CAD with modeling capability	1	1
	Production student	Personal computer	1	2
2	Design student	2-D CAD	1	3
	Production student	Personal computer	1	4
Odd n	Design student	3-D CAD without modeling	1	2 n-1
	Production student	Personal computer	1	2 n
Even n	Design student	2-D CAD	1	2 n-1
	Production student	Personal computer	1	2 n

Requirements Table - CAD/CAM Problems

Summary

A four course capability using the present quarter system suggested sequence, in Section II, which does not require operating CAD courses concurrently may be supported by the following items.

Equipment	Number Required
3-D CAM with modeling capability	1
3-D CAM (without modeling capability	½ n for design student minus 1
2-D CAM	½ n for design students
Personal computer	n for production students
Computer controlled production system (NC, CNC, or DNC)	1

Requirements Table - Composite

Textile bag .....( )

Canvas goods .....( )

Lumber and wood:
- Logs and poles .....( )
- Lumber.....( )
- Veneer and plywood .....( )
- Wooden containers.....( )

Furniture and fixtures:
- Household furniture .....( )
- Upholstered household furniture .....( )
- Mattresses and bedsprings.....( )
- Office furniture .....( )
- Partitions, shelving, and lockers.....( )
- Office and store fixtures ....( )
- Venetian blinds and shades....( )

Pulp mill .....( )

Paper mill:
- Paper coated and glazed.....( )
- Envelopes .....( )
- Paper bags .....( )
- Wallpaper .....( )
- Paperboard and cardboard .....( )
- Pressed and molded.....( )
- Sanitary paper goods .....( )

Building paper and boards.....( )

Printing:
- Periodicals .....( )
- Books .....( )
- Atlas .....( )
- Directories .....( )
- Patterns .....( )
- Business forms .....( )
- Greeting cards .....( )
- Bank books .....( )

Chemicals:
- Alkalies and chlorine.....( )
- Industrial gases .....( )
- Dyes and organic pigments ....( )
- Inorganic pigments .....( )
- Industrial organic chemicals..( )
- Industrial inorganic chemicals( )
- Plastics and synthetic resins.( )
- Synthetic rubbers.....( )
- Synthetic fibers.....( )
- Synthetic organic fibers .....( )
- Drugs .....( )
- Pharmaceutical preparations...( )
- Soaps and detergents.....( )
- Specialty cleaners.....( )
- Surface active agents.....( )
- Perfumes, cosmetics, and toilet preparations.....( )
- Paints, varnishes, and allied products .....( )
- Gum and wood chemicals.....( )
- Agricultural chemicals.....( )
- Adhesives and gelatin.....( )
- Explosives .....( )
- Printing ink .....( )
- Carbon black .....( )

Petroleum:
- Refined petroleum .....( )
- Paving and roofing materials..( )
- Asphalt felts and coatings....( )
- Lubricating oils and greases..( )

Rubber:
- Tires and inner tubes .....( )
- Rubber footwear .....( )
- Fabricated rubber goods.....( )
- Fabricated plastic goods.....( )

Leather:
- Tanned and finished leather...( )
- Industrial leather belting and packing.....( )
- Boot and shoe leather .....( )
- Gloves and mittens.....( )
- Luggage .....( )
- Handbags .....( )
- Personal leather goods.....( )

Nonmetallic minerals:
- Glass .....( )
- Glass containers.....( )
- Pressed and blown glass and glassware .....( )
- Cement.....( )
- Brick and structural clay tile( )
- Ceramic wall and floor tile...( )
- Clay refractories.....( )
- Vitreous china plumbing fixtures.....( )
- Vitreous china table and kitchenware .....( )
- Fine earthenware .....( )
- Porcelain electrical goods....( )
- Concrete block and brick.....( )
- Concrete goods .....( )
- Ready-mix concrete .....( )
- Lime .....( )
- Gypsum .....( )
- Cut and dimension stone.....( )

COMPUTER ASSISTED DESIGN/MANUFACTURING

O C C U P A T I O N A L I N V E N T O R Y C H E C K L I S T

Firm: _____ Date of Inventory: _____ By: _____

PART I

THE PRODUCT AREA(S)

Mining:
- Metallic ores .....( )
- Nonferrous ores .....( )
- Precious metals .....( )
- Ferroalloys.....( )
- Coal.....( )
- Petroleum.....( )
- Natural gas .....( )
- Stone .....( )
- Sand and gravel .....( )
- Nonmetallic minerals.....( )
- Chemical minerals.....( )

Construction:
- Highways and streets.....( )
- Heavy construction structures.( )
- Plumbing installations.....( )
- Heating installations.....( )
- Air conditioning installations( )
- Electrical work installations.( )
- Masonry and set stone installations.....( )
- Carpentry work installations..( )
- Roofing installations.....( )
- Sheet metal installations.....( )
- Concrete work installations...( )
- Structural steel installations( )
- Elevator installations.....( )

Ordnance:
- Large ordnance.....( )
- Small arms.....( )
- Large ordnance ammunition.....( )
- Small arms ammunition.....( )

Sighting and fire control equipment.....( )

Food:
- Meats and meat products.....( )
- Poultry .....( )
- Dairy .....( )
- Canned and preserved fruits...( )
- Canned and cured fish and sea foods .....( )
- Dried and dehydrated fruits and vegetables.....( )
- Pickled fruits and vegetables.( )
- Fresh or frozen foods.....( )
- Grain mill.....( )
- Bakery .....( )
- Sugar .....( )
- Confectionery .....( )
- Beverages .....( )
- Oils and shortenings.....( )

Tobacco .....( )

Textile mill:
- Woven fabrics.....( )
- Knitted fabrics.....( )
- Dyed and finished fabrics.....( )
- Floor coverings.....( )
- Yarn and thread .....( )
- Felt goods .....( )
- Lace goods.....( )
- Paddings and upholstery fillings.....( )
- Artificial leather and coated fabrics.....( )
- Tire cord and fabric .....( )
- Cordage and twine .....( )

Apparel:
- Men's apparel .....( )
- Women's apparel .....( )
- Boy's apparel .....( )
- Girl's apparel .....( )
- Sportswear .....( )
- Hat, cap, and millinery .....( )
- Fur goods .....( )
- Gloves .....( )
- Robes and dressing gowns.....( )
- Raincoats .....( )
- Leather clothing.....( )

Curtains and drapes .....( )

House furnishings .....( )

Abrasives .....( )
Asbestos .....( )
Gaskets packing and asbestos insulation.....( )
Minerals and earths.....( )
Mineral wool .....( )
Nonclay refractories.....( )

Metals, Primary:
Pig iron .....( )
Steel .....( )
Hot rolled steel sheet, strips and bars .....( )
Electrometallurgical goods....( )
Wire drawn goods.....( )
Cold rolled steel sheet, strips and bars .....( )
Steel pipes and tubes .....( )
Foundry castings.....( )
Nonferrous metal smelting.....( )
Nonferrous metal refining.....( )
Secondary nonferrous smelting.( )
Secondary nonferrous metal refining.....( )
Nonferrous metal rolling drawing and extruding .....( )
Nonferrous wire drawing and insulating .....( )
Iron and steel forgings.....( )
Nonferrous forgings.....( )

Metals, Fabricated:
Metal cans.....( )
Cutlery .....( )
Hand and edge tools.....( )
Hand saws and blocks.....( )
Enameled iron and metal sanitary ware .....( )
Plumbing fixture fittings and trim.....( )
Nonelectric heating equipment.( )
Structural steel .....( )
Metal doors, sashes, and frames.....( )
Boiler plate work.....( )
Sheetmetal .....( )
Architectural and ornamental metalwork.....( )
Screw machine.....( )
Bolts, nuts, screws, rivets and washers.....( )
Metal stampings.....( )
Electroplated goods.....( )
Engraved goods.....( )
Fabricated wire goods.....( )
Barrels, drums, and kegs.....( )
Safes and vaults.....( )
Steel springs.....( )
Valves and pipe fittings.....( )
Collapsible tubes.....( )
Metal foil and leaf.....( )
Fabricated pipe and fittings..( )

Machinery:
Engines and turbines.....( )
Internal combustion engines...( )
Farm machinery and equipment..( )
Construction machinery and equipment.....( )
Mining machinery and equipment( )
Oil field machinery and equipment.....( )
Elevators and moving stairways( )
Conveyors and conveying equipment.....( )
Hoists, cranes, and monorail systems.....( )
Industrial trucks, tractors, and trailers.....( )
Metal cutting machine tools...( )
Metal forming machine tools...( )
Dies and tools, die sets, jigs and fixtures.....( )
Machine tool accessories.....( )
Measuring devices.....( )
Metal working machinery .....( )
Power driven handtools.....( )
Food products machinery.....( )
Textile machinery.....( )
Woodworking machinery.....( )
Paper industries machinery....( )
Printing trades machinery and equipment.....( )
Special industry machinery....( )
Pumps, compressors and pumping equipment.....( )
Blowers and fans.....( )
Industrial patterns.....( )
Mechanical power transmission equipment.....( )
Industrial process furnaces and ovens.....( )
Office machines.....( )
Computing machines.....( )
Accounting machines.....( )
Scales and balances.....( )
Automatic merchandising machines.....( )
Laundry drycleaning and pressing machines.....( )
Air conditioning equipment....( )
Refrigeration machinery and equipment.....( )
Measuring and dispensing pumps( )

Service industry machines.....( )

Electrical machinery and equipment:
- Measuring instruments.....( )
- Test equipment.....( )
- Power distribution equipment..( )
- Switchgear and switchboard apparatus .....( )
- Motors and generators.....( )
- Industrial controls.....( )
- Welding apparatus.....( )
- Carbon and graphite goods.....( )
- Industrial apparatus.....( )
- Household appliances.....( )
- Household laundry equipment...( )
- Electric housewares and fans..( )
- Household vacuum cleaners.....( )
- Sewing machines.....( )
- Electric lamps.....( )
- Lighting fixtures.....( )
- Current carrying devices.....( )
- Noncurrent carrying devices...( )
- Radio and TV sets.....( )
- Signalling and detection equipment.....( )
- Electron tubes.....( )
- Cathode ray picture tubes.....( )
- Transmitting and industrial electron tubes.....( )
- Semiconductors and related devices.....( )
- Electronic components.....( )
- Storage batteries.....( )
- X-ray apparatus and tubes.....( )
- Electromedical apparatus.....( )
- Electrotherapeutic apparatus..( )
- Automotive electrical equipment.....( )

Transportation equipment:
- Motor vehicles.....( )
- Motor vehicle parts and accessories.....( )
- Aircraft .....( )
- Aircraft engines and parts....( )
- Aircraft propellers and parts.( )
- Aircraft auxiliary equipment..( )
- Ships.....( )
- Boats.....( )
- Locomotives and parts.....( )
- Railroad and streetcar parts..( )
- Motorcycle, bicycle and parts.( )
- Trailer coaches.....( )

Instruments:
- Engineering.....( )
- Laboratory .....( )
- Scientific and research.....( )
- Mechanical measuring and controlling.....( )

Orthopedic, prosthetic, and surgical appliances.....( )

Dental equipment and supplies....( )

Ophthalmic goods.....( )

Photographic equipment and supplies.....( )

Watches, clocks, and clock operated devices.....( )
- Watch parts.....( )

Jewelry .....( )
- Precious metal jewelry.....( )
- Jewelry findings.....( )
- Lapidary goods.....( )
- Silverware and plated ware ...( )

Musical instruments.....( )

Toys and games.....( )
- Dolls.....( )
- Children's vehicles.....( )
- Sporting goods.....( )

Pens and pencils.....( )
- Marking devices.....( )
- Carbon paper and inked ribbons( )

Costume jewelry.....( )

Artificial flowers.....( )

Buttons.....( )

Needles, pins, hooks and eyes....( )

Brooms and brushes.....( )

Signs and advertising displays...( )

Mortician goods.....( )

Linoleum and hard surfaced floor coverings.....( )

Other (Specify) .....( )

PART II

MACHINES, TOOLS, EQUIPMENT AND WORK AIDS
USED DURING PRODUCTION

Machines:
- Centrifuges.....( )
- Pumps.....( )
- Bend fatigue machines.....( )
- Vibrators.....( )
- Separators.....( )
- Hydraulic presses.....( )
- Air compressors .....( )
- Vibratory screens.....( )
- Hardness testers.....( )
- Burst testers.....( )
- Other (Specify) .....( )

Tools:

Handtools:
- Drills.....( )
- Chisels.....( )
- Files.....( )
- Knives.....( )
- Rules.....( )
- Scissors.....( )
- Tapes.....( )
- Scribes.....( )
- Sidecutters.....( )
- Wirecutters.....( )
- Wire strippers.....( )
- Levels.....( )
- Awls.....( )
- Pliers.....( )
- Screwdrivers.....( )
- Brushes.....( )
- Wrenches.....( )
- Stylus.....( )
- Clippers.....( )
- Needles.....( )
- Squares.....( )
- Other (Specify) .....( )

Equipment:
- Driers.....( )
- Ovens.....( )
- Furnaces.....( )
- Scales.....( )
  - Torsion balance scale.....( )
  - Balance scales.....( )
  - Analytical scales.....( )
- Fractional distillation equipment.....( )
- Magnaflux equipment.....( )
- Ultrasonic test equipment.....( )
- Other (Specify) .....( )

Work Aids:

Mechanical measuring devices:
- Calipers.....( )
- Verniers.....( )
- Dividers.....( )
- Bevel protractor.....( )
- Protractor.....( )

Gauges:
- Center gauge.....( )
- Feeler gauge.....( )
- Balance gauge.....( )
- Height gauge.....( )
- Pressure gauge.....( )
- Plug gauge .....( )
- Radius gauge .....( )
- Screw pitch gauge .....( )
- Surface gauge .....( )
- Telescoping gauge .....( )
- Thickness gauge .....( )
- Go No-go gauge .....( )
- Thread gauge .....( )
- Wire gauge .....( )
- Pin gauge .....( )
- Ball gauge .....( )

Micrometers:
- Depth micrometer.....( )
- Flange micrometer.....( )
- Inside micrometer.....( )
- Outside micrometer.....( )
- Swiss hole micrometer.....( )
- Electronic micrometer.....( )

Gauge blocks:
- Johanason blocks.... .....( )
- Parallel blocks.....( )
- V blocks.....( )
- Sine bars .....( )

Angle plates.....( )

Quadrants .....( )

Straight edges .....( )

Footage counters.....( )

Yardage counters.....( )

Depth rules.....( )

Formulas .....( )
Approval slips .....( )
Rejection slips .....( )
Inspection orders .....( )
Samples .....( )
Records .....( )
Graphs .....( )
Tables .....( )
Specimens .....( )
Specifications .....( )
Test sheets .....( )
Holding devices .....( )

Jigs .....( )
Fixtures .....( )
Master samples .....( )
Color samples .....( )
Specifications manual .....( )
Blueprints .....( )
Sketches .....( )
Plumb bob .....( )
Magnifying glass .....( )
Timing light .....( )
Other (Specify) .....( )

PART III

WHAT THE TECHNICIAN DOES

Position primarily in CAD .....( )

Position primarily in CAM .....( )

Supervises, and coordinates activities, of workers engaged in design or manufacturing of materials and products.....( )

Plans and determines:
- Manpower requirements.....( )
- Worker schedules.....( )
- Design or production procedures.....( )
- Training requirements.....( )
- Product inspection and testing requirements.....( )

Prepares work schedules.....( )

Assigns workers to duties.....( )

Gives workers directions for performing duties.....( )

Interprets inspection and testing orders, product, specifications, drawings, and technical data...( )

Trains workers in:
- Design or manufacturing duties.....( )
- Operation of equipment.....( )
- Safety practices and regulations.....( )

Advises workers on methods and procedures for solving problems( )

Coordinates quality assurance activities with production activities .....( )

Enforces compliance with established work procedures, regulations, and safety rules.....( )

Recommends promotions, demotions, discharges, and disciplinary actions.....( )

Requisitions materials, tools and equipment.....( )

Evaluates workers and prepares performance reports.....( )

Prepares reports on quality assurance activities.....( )

Performs periodic checks on products and materials.....( )

Other (Specify) .....( )

Develops specifications on materials, products, or product parts for:

Physical, Chemical, and Electrical characteristics:
- Alignment of parts.....( )
- Width.....( )
- Length.....( )
- Thickness.....( )
- Flatness.....( )
- Tolerances.....( )
- Shape and contour.....( )
- Volume .....( )
- Angular dimensions.....( )
- Radii.....( )
- Coating thickness.....( )
- Dioptic power.....( )
- Height .....( )
- Lens focal distance.....( )
- Clearances between moving parts.....( )
- Acidity .....( )
- Alkalinity .....( )
- Absorption qualities.....( )
- Solubility.....( )
- Sediment.....( )
- Turbidity .....( )
- Viscosity .....( )
- Specific gravity .....( )
- Dielectric strength .....( )
- Melting point.....( )
- Hardness .....( )
- Ductility .....( )
- Boiling point .....( )
- Compression characteristics...( )
- Vapor point .....( )
- Malleability .....( )
- Condensation point .....( )
- Flash point .....( )
- Aniline point.....( )
- Freezing point .....( )
- Porosity .....( )

Salinity .....( )
Permeability .....( )
Tensile strength .....( )
Elongation capabilities.....( )
Heat resistance.....( )
Alcohol content .....( )
Fade resistance.....( )
Density of color.....( )
Light values.....( )
Sugar content.....( )
Insulation efficiency.....( )
Adhesive qualities.....( )
Load test capabilities.....( )
Mechanical characteristics....( )
Waterprcofing qualities.....( )
Washability.....( )
Polarity .....( )
Voltage .....( )
Amperage .....( )
Inductance.....( )
Shorts .....( )
Grounds.....( )
Capacitance.....( )
Circuit continuity .....( )
Specified horsepower .....( )
Other (Specify) .....( )

Performs Research:
Studies blueprints, schematics, and circuit diagrams.....( )
Reviews product specifications.....( )
Reviews type and extent of test specified .....( )
Tests product or part under simulated operational conditions.....( )
Reads gauges, indicators and meters on test equipment....( )
Refers to charts or tables for specified test readings.....( )
Compares readings to ascertain discrepancies.....( )
Analyzes test results.....( )
Diagnoses cause of malfunction or discrepancies.....( )
Records number and type of defects on inspection record( )
Compiles testing data for purposes .....( )
Conducts acceptance or performance tests .....( )
Other (Specify) .....( )

PART IV

ENTRY REQUIREMENTS

LICENSURE, CERTIFICATES NEEDED

Federal .....( )

State .....( )

County .....( )

City .....( )

Other (Specify).....( )

COMMUNICATION RESPONSIBILITIES

Management .....( )

Other supervisors.....( )

Quality control personnel .....( )

R & D personnel .....( )

Workers.....( )

Federal agencies.....( )

State agencies.....( )

Other (Specify) .....( )

OCCUPATIONAL ENTRY EDUCATION AND TRAINING LEVELS

High school .....( )

Junior college .....( )

College .....( )

Technical training.....( )

Vocational training.....( )

On-The-Job training.....( )

Military training.....( )

Apprenticeship training.....( )

Other (Specify) .....( )

EDUCATIONAL REQUIREMENTS

Algebra.....( )

Geometry .....( )

Shop mathematics.....( )

Applied science.....( )

Properties of metals.....( )

Properties of materials.....( )

Materials of industry .....( )

Use and care of tools.....( )

Use and care of measuring devices.....( )

Use and care of testing equipment .....( )

Use and care of laboratory equipment.....( )

Elements of basic metallurgy....( )

Applied chemistry .....( )

Human behavior of employees.....( )

Elements of leadership.....( )

Foremanship and supervision.....( )

Mechanical drawing.....( )
- Orthographic projection.....( )
- Sectional views.....( )
- Auxiliary views.....( )
- Isometric projection.....( )
- Lettering.....( )

Blueprint reading.....( )

Magnetism and electrical energy.( )

Science matter and measurement..( )

Procurement:
- Procurement principles and techniques.....( )
- Inspection.....( )
- Planning.....( )
- Control.....( )
- Performance.....( )
- Lot control.....( )
- Non-conforming supplies.....( )
- Corrective action.....( )

Theory and application:
- Fundamentals of statistical analysis.....( )
- Case problem solving applications.....( )

Management concepts:
- Quality and reliability assurance.....( )
- Organization and objectives..( )
- Documentation.....( )
- Planning and costs.....( )

Quality control specifications:
- Government specifications....( )
- Regulatory agency specifications.....( )

Quality control planning:
- Procedures.....( )
- Policies.....( )
- Systems.....( )

Quality control documentation:
- Document preparation.....( )
- Document distribution.....( )
- Document control.....( )

Other (Specify) .....( )

CAD OCCUPATIONAL COMPETENCIES CHECKLIST

FIRM:
NAME:
DATE:

CHECK APPLICABLE BLOCK

A. Competent in terminology and description of the purpose of:	N/A	Low Use	High Use
1. categories of CAD equipment			
2. the CAD program language			
3. CAD storage systems			
4. the CAD system function board			
5. the CAD system process memory			
6. the CAD system graphics tablet			
7. the CAD system pen plotter			
8. the computer aided manufacturing by numerical control			
9. the computer aided manufacturing by robotics			
10. CAD basic commands and functions			
11. purpose of the display file			
12. three-dimensional viewing			
13. INPUT techniques			

CAD OCCUPATIONAL COMPETENCIES CHECKLIST

	N/A	Low Use	High Use
14. system transformations			
15. software graphic and nongraphic data base			
16. major hardware components of a graphics production system			
17. recording devices			
18. display devices			
19. work station input devices			

B. Competent in describing:

1. the advantages of a CAD method when compared with manual instrument method			
2. the disadvantages of a CAD method when compared with manual instrument method			
3. CAD system start up procedures			
4. CAD system point positioning procedures			
5. CAD system function board			
6. the method of digitizing the CAD system			
7. the purpose of the CAD system light pen			
8. generating a line with a CAD system			
9. the procedure for generating a circle using the CAD system			
10. the CAD system procedure for generating an irregular curve or spline			

	N/A	Low Use	High Use
11. the CAD system procedure for generating dimension notations			
12. the CAD system procedure for generating text for graphics			
13. the CAD system procedure for generating graphic changes by geometry modifiers			
14. the fields in which computer graphics have application in the overall range of occupations			
15. major hardware components of a graphics production system			
16. the purpose of recording devices			
17. the purpose of display devices			
18. the purpose of work station input devices			

C. Competent in demonstrating the operational skills associated with:

1. CAD system start up			
2. CAD system point positioning			
3. using the CAD system function board			
4. digitizing the CAD system			
5. line generation using the CAD system			
6. generating a circle using the CAD system			
7. generating an irregular curve or spline			
8. CAD system generation of dimension notations			

CAD OCCUPATIONAL COMPETENCIES CHECKLIST

	N/A	Low Use	High Use
9. CAD system generation of text for graphics			
10. CAD system generation of graphic changes by geometry modifiers			
11. CAD system mechanical drawing using a function board			
12. CAD system generation at a schematic diagram using a function board			
13. CAD system mechanical drawing using a graphics tablet			
14. CAD system production at a piping diagram using a graphics tablet			
15. CAD system production of a mechanical drawing using a light pen			
16. CAD system symbol development using a joystick			
17. CAD system graphics editing by ERASE modifier			
18. CAD system graphics editing by the DELETE modifier			
19. CAD system graphics editing by the REDRAW function			
20. CAD system graphics editing by the SHIFT, OFFSET or REPOSITION procedure			
21. CAD system graphics editing by the SCALE or SIZE function			
22. the CAD system method of storing or filing documents			
23. the CAD system method of establishing a library of files			
24. using the CAD system to do sectioning			
25. using the CAD system to rotate graphics			

CAM OCCUPATIONAL COMPETENCIES CHECKLIST

	N/A	Low Use	High Use
26. using the CAD system to generate a three-dimensional drawing			
27. using the CAD system to generate a bill of materials			
28. three-dimensional viewing			
29. system transformations			
30. INPUT techniques			
31. kinematics graphics			

CAM OCCUPATIONAL COMPETENCIES CHECKLIST

FIRM:
NAME:
DATE:

CHECK APPLICABLE BLOCK

	N/A	Low Use	High Use
A. Competency in terminology and description of purpose of computer aided manufacturing (CAM):			
1. catagories of equipment			
2. program language			
3. data storage security system			
4. INPUT techniques			
5. system transformations			
6. process monitoring devices			
7. work station data input and function controls			
8. processes and procedures			
B. Competency in describing:			
1. the advantages of a CAM system in comparison with conventional manufacturing procedures and processes			
2. the advantages of a conventional manufacturing system when compared with a CAM system			
C. Competency in demonstrating the operational skills associated with:			
1. making computer application analysis for CAM systems			

CAM OCCUPATIONAL COMPETENCIES CHECKLIST

	N/A	Low Use	High Use
2. writing a basic CAM system program			
3. selecting CAM software			
4. modifying CAM system software			
5. scheduling job orders			
6. requisitioning materials			
7. flow charting production assembly lines			
8. protection and control of production resources			
9. planning and scheduling the assembly of components into a product			
10. planning and scheduling packaging			
11. planning and scheduling shipping of product			
12. developing and writing production reports			
13. making oral reports			
14. analysis of time and motion			
15. conducting a cost analysis			
16. analysis of production methods and processes			
17. developing job status reports			
18. writing technical reports			

CAM OCCUPATIONAL COMPETENCIES CHECKLIST

	N/A	Low Use	High Use
19. developing informational charts, diagrams and graphs			
20. advising on "make or buy" decisions			
21. developing sources of supply			
22. obtaining bids and quotations			
23. selecting vendors			
24. issuing purchase requests			
25. receiving and inspecting incoming materials			
26. planning, scheduling and distributing materials to production area			
27. developing engineering change notices and rejection reports			
28. writing change notices and modification recommendations			
29. developing and conducting quality control procedures			
30. analysis of varying environmental conditions			
31. Numerical Control (NC) systems			
32. Computer Numerical Control (CNC) systems			
33. Direct Numerical Control (DNC) systems			
34. Integrated design and manufacturing computer-based programs			

ENGINEERING AND SCIENCE TECHNICIANS*

Nature of the Work

Knowledge of science, mathematics, industrial machinery, and technical processes enables engineering and science technicians to work in all phases of business and government, from research and design to manufacturing, sales, and customer service. Although their jobs are more limited in scope and more practically oriented than those of engineers or scientists, technicians often apply the theoretical knowledge developed by engineers and scientists to actual situations. Technicians frequently use complex electronic and mechanical instruments, experimental laboratory equipment, and drafting instruments. Almost all technicians described in this statement must be able to use technical handbooks and calculators, and some must work with computers.

In research and development, one of the largest areas of employment, technicians set up experiments and calculate the results, sometimes with the aid of computers. They also assist engineers and scientists in developing experimental equipment and models by making drawings and sketches and, frequently, by doing routine design work.

In production, technicians usually follow the plans and general directions of engineers and scientists, but often without close supervision. They may prepare specifications for materials, devise tests to insure product quality, or study ways to improve the efficiency of an operation. They often supervise production workers to make sure they follow prescribed plans and procedures. As a product is built, technicians check to see that specifications are followed, keep engineers and scientists informed on progress, and investigate production problems.

As sales workers or field representatives for manufacturers, technicians give advice on installation and maintenance of complex machinery, and may write specifications and technical manuals.

Technicians may work in engineering, physical science, or life science. Within these general fields, job titles may describe the level (biological aide or biological technician), duties (quality control technician or time study analyst), or area of work (mechanical, electrical, or chemical).

An engineering technician might work in any of the following areas:

Aeronautical Technology.

Technicians in this area work with engineers and scientists to design and produce aircraft, rockets, guided missiles, and spacecraft. Many aid engineers in preparing design layouts and models of structures, control systems, or equipment installations by collecting information, making computations, and

207

performing laboratory tests. For example, a technician might estimate weight factors, centers of gravity, and other items affecting load capacity of an airplane or missile. Other technicians prepare or check drawings for technical accuracy, practicability, and economy.

Aeronautical technicians frequently work as manufacturers' field service representatives, serving as the link between their company and the military services, commercial airlines, and other customers. Technicians also prepare technical information for instruction manuals, bulletins, catalogs, and other literature.

Air-Conditioning, Heating, and Refrigeration Technology.

Air-conditioning, heating, and refrigeration technicians design, manufacture, sell, and service equipment to regulate interior temperatures. Technicians in this field often specialize in one area, such as refrigeration, and sometimes in a particular type of activity, such as research and development.

When working for firms that manufacture temperature-controlling equipment, technicians generally work in research and engineering departments, where they assist engineers and scientists in the design and testing of new equipment or production methods. For example, a technician may construct an experimental model to test its durability and operating characteristics. Technicians also work as sales workers for equipment manufacturers or dealers, and must be able to supply engineering firms and other contractors that design and install systems with information on installation, maintenance, operating costs, and the performance specifications of the equipment. Other technicians work for contractors, where they help design and prepare installation instructions for air-conditioning, heating, or refrigeration systems. Still others, in customer service, are responsible for supervising the installation and maintenance of equipment.

Civil Engineering Technology.

Technicians in this area assist civil engineers in planning, designing, and constructing highways, bridges, dams, and other structures. They often specialize in one area, such as highway or structural technology. During the planning stage, they estimate cost, prepare specifications for materials, or participate in surveying, drafting, or designing. Once construction begins, they assist the contractor or superintendent in scheduling construction activities or inspecting the work to assure conformance to blueprints and specifications.

Electronics Technology.

Technicians in this field develop, manufacture, and service electronic equipment and systems. The types of equipment range from radio, radar, sonar, and television to industrial and medical measuring or control devices, navigational equipment, and computers. Because the field is so broad, technicians often specialize in one area, such as automatic control devices or electronic amplifiers. Furthermore, technological advancement is constantly opening up new areas of work such

as integrated circuit technology.

When working in design, production, or customer service, electronic technicians use sophisticated measuring and diagnostic devices to test, adjust, and repair equipment. In many cases, they must understand the field in which the electronic device is being used. To design equipment for space exploration, for example, they must consider the need for minimum weight and volume and maximum resistance to shock, extreme temperature, and pressure. Some electronics technicians also work in technical sales, while others work in the radio and television broadcasting industry.

Industrial Production Technology.

Technicians in this area, usually called industrial or production technicians, assist industrial engineers on problems involving the efficient use of personnel, materials, and machines to produce goods and services. They prepare layouts of machinery and equipment, plan the flow of work, make statistical studies, and analyze production costs. Industrial technicians also conduct time and motion studies (analyze the time and movements a worker needs to accomplish a task) to improve the production methods and procedures in manufacturing plants.

Many industrial technicians acquire experience that enables them to qualify for other jobs. For example, those specializing in machinery and production methods may move into industrial safety. Others, in job analysis, may set job standards and interview, test, hire, and train personnel. Still others may move into production supervision.

Mechanical Technology.

Mechanical technology is a broad term that covers a large number of specialized fields including automotive, diesel, and production technology and tool and machine design.

Many mechanical engineering technicians assist engineers in design and development work by making freehand sketches and rough layouts of proposed machinery and other equipment and parts. This work requires knowledge of mechanical principles involving tolerance, stress, strain, friction, and vibration factors. Technicians also analyze the costs and practical value of designs.

In planning and testing experimental machines and equipment for performance, durability, and efficiency, technicians record data, make computations, plot graphs, analyze results, and write reports. They sometimes recommend design changes to improve performance. Their job often requires skill in the use of complex instruments, test equipment, and gauges, as well as in the preparation and interpretation of drawings.

When a product is ready for production, technicians help prepare layouts and drawings of the assembly process and of parts to be manufactured. They frequently help estimate labor

209

costs, equipment life, and plant space. Some mechanical technicians test and inspect machines and equipment in manufacturing departments or work with engineers to eliminate production problems. Others are technical sales workers.

Tool designers are among the better known specialists in mechanical engineering technology. Tool designers prepare sketches of designs for cutting tools, jigs, dies, special fixtures, and other devices used in mass production. Frequently, they redesign existing tools to improve their efficiency. They also make, or supervise others who make detailed drawings of tools and fixtures.

Instrumentation Technology.

Automated manufacturing and industrial processes, oceanograhic and space exploration, weather forecasting, satellite communication systems, environmental protection, and medical research have helped to make instrumentation technology a fast-growing field. Technicians help develop and design complex measuring and control devices such as those in a spacecraft that sense and measure changes in heat or pressure, automatically record data, and make necessary adjustments. These technicians have extensive knowledge of physical sciences as well as electrical and electronic and mechanical engineering.

Several areas of opportunity exist in the physical sciences: Chemical technicians work with chemists and chemical engineers to develop, sell, and utilize chemical and related products and equipment. Most chemical technicians do research and development, testing, or other labor- atory work. They often set up and conduct tests on processes and products being developed or improved. For example, a technician may examine steel for carbon, phosphorus, and sulfur content or test a lubricating oil by subjecting it to changing temperatures. The technician measures reactions, analyzes the results of experiments, and records data that will be the basis for decisions and future research.

Chemical technicians in production generally put into commercial operation those products or processes developed in research laboratories. They assist in making the final design, installing equipment, and training and supervising operators on the production line. Technicians in quality control test materials, production processes, and final products to insure that they meet the manufacturer's specifications and quality standards. Many also sell chemicals or chemical products as technical sales personnel.

Many chemical technicians use computers and instruments, such as a dilatometer (which measures the expansion of a substance.) Because the field of chemistry is so broad, chemical technicians frequently specialize in a particular industry, such as food processing or pharmaceuticals.

Mathematical technicians work with scientific and engineering personnel to solve technological problems encountered in research and development and other areas. They

apply standardized mathematical formulas to raw data to help translate these data into usable equations, graphs, and other forms. Mathematical technicians often use computers, card punch machines, calculators, and data processing equipment.

Meteorological technicians support meteorologists in the study of atmospheric conditions. Technicians calibrate instruments, observe, record, and report meteorological occurrences, and assist in research projects and the development of scientific instruments.

Geological technicians assist geologists in evaluating earth processes. Currently much research is being conducted in seismology, petroleum and mineral exploration, and ecology. These technicians install and record measurements from seismographic instruments, assist in field evaluations of earthquake damage and surface displacement, or assist geologists in earthquake prediction research. In petroleum and mineral exploration, they help conduct tests and record sound wave data to determine the likelihood of successful drilling, or use radiation detection instruments and collect core samples to help geologists evaluate the economic possibilities of mining a given resource.

Hydrologic technicians gather data to help hydrologists predict river stages and water quality levels. They monitor instruments that measure water flow, water table levels, or water quality, and record and analyze the data obtained.

Technicians in the life sciences generally are classified in either of two broad categories:

Agricultural technicians work with agricultural scientists in food production and processing. Plant technicians conduct tests and experiments to improve the yield and quality of crops, or to increase resistance to disease, insects or other hazards. Technicians in soil science analyze the chemical and physical properties of various soils to help determine the best uses for these soils. Animal husbandry technicians work mainly with the breeding and nutrition of animals. Other agricultural technicians are employed in the food industry as food processing technicians. In quality control or in food science research they help scientists develop better and more efficient ways of processing food material for human consumption.

Biological technicians work primarily in laboratories where they perform tests and experiments under controlled conditions. Microbiological technicians study microscopic organisms and may be involved in immunology or parasitology research. Laboratory animal technicians study and report on the reaction of laboratory animals to certain physical and chemical stimuli. They also study and conduct research to help biologists develop cures for human diseases. By conducting experiments and reporting the results to a biochemist, technicians assist in analyzing biological substances (blood, other body fluids, foods, and

drugs). A biological technician also might work with insects to study insect control, develop new insecticides, or determine how to use insects to control other insects or undesirable plants.

Technicians also specialize in fields such as metallurgical (metal) electrical, and optical technolgoy. In the atomic energy field, technicians work with scientists and engineers on problems of radiation safety, inspection, and decontamination. Other areas of work include environmental protection, where technicians study the problems of air and water pollution, and industrial safety.

Working Conditions

Technicians work under a wide variety of conditions. Most work regular hours in laboratories and industrial plants. Others work part or all of their time outdoors. Some occasionally are exposed to safety or health hazards from equipment or materials.

Places of Employment

Over 885,000 persons worked as engineering and science technicians in 1980. About two-thirds of all technicians worked in private industry. In the manufacturing sector, the largest employers were the electrical equipment, chemical, machinery, and aerospace industries. In nonmanufacturing, large numbers worked in wholesale and retail trade, communications, and in engineering and architectural services industries.

In 1980 the Federal Government employed about 180,000 technicians, chiefly as engineering and electronics technicians, biological technicians, cartographic (mapmaking) technicians, meteorological technicians, and physical science technicians. The largest number worked for the Department of Defense; most of the others worked for the Departments of Transportation, Agriculture, Interior and Commerce.

State government agencies employed nearly 50,000 engineering and science technicians, and local governments about 13,500. The remainder worked for colleges and universities and nonprofit organizations.

Training, Other Qualifications, and Advancement

Although persons can qualify for technician jobs through many combinations of work experience and education, most employers prefer applicants who have had some specialized technical training. Specialized training is available at technical institutes, junior and community colleges, area vocational-technical schools, extension divisions of colleges and universities, and vocational-technical high schools. Some engineering and science students who have not completed the bachelor's degree and others who have degrees in science and mathematics also are able to qualify for technician positions.

Persons also can qualify for technical jobs by less formal methods. Workers may

learn through on-the-job training, apprenticeship programs, or correspondence schools. Some qualify on the basis of experience gained in the Armed Forces. However, postsecondary training is becoming increasingly necessary for advancement to more responsible jobs.

Some of the types of postsecondary and other schools that provide technical training are discussed in the following paragraphs:

Technical Institutes. Technical institutes offer training to qualify students for a job immediately after graduation with a minimum of on-the-job training. In general, students receive intensive technical training but less theory and general education than in engineering schools or liberal arts colleges. A few technical institutes and community colleges offer cooperative programs in which students spend part of the time in school and part in paid employment related to their studies.

Some technical institutes operate as regular or extension divisions of colleges and universities. Other institutions are operated by states and municipalities, or by private organizations.

Junior and Community Colleges. Curriculums in junior and community colleges which prepare students for technician occupations are similar to those in technical institutes but emphasize theory and liberal arts. After completing the 2-year programs, some graduates qualify for technical jobs while others continue their education at 4-year colleges.

Area Vocational-Technical Schools. These postsecondary public institutions serve students from surrounding areas and emphasize training in skills needed by employers in the local area. Most require a high school degree or its equivalent for admission.

Other Training. Some large corporations conduct training programs and operate private schools to meet the needs of technically trained personnel in specific jobs; such training rarely includes general studies. Training for some technician occupations, for instance tool designers and electronic technicians, is available through formal 2- to 4-year apprenticeship programs. The apprentice gets on-the-job training under the close supervision of an experienced technician and related technical knowledge in classes, usually after working hours.

The Armed Forces have trained many technicians, especially in electronics. Although military job requirements generally differ from those in the civilian economy, military technicians often find employment with only minimal additional training.

Many private technical and correspondence schools often specialize in a single field of technical training such as electronics. Some of these schools are owned and operated by large corporations that have the resources to provide up-to-date training in a technical field.

Those interested in a career as a technician should have an aptitude for mathematics and science and enjoy technical work. An ability to do detailed work with a high degree of accuracy is necessary; for design work, creative talent also is desirable. Technicians are part of a scientific team, and often work closely with engineers and scientists as well as other technicians and skilled workers. Some technicians, such as repair and maintenance technicians, should be able to work independently and to deal effectively with customers.

Engineering and science technicians usually begin work as trainees in routine positions under the direct supervision of an experienced technician, scientist, or engineer. As they gain experience, they receive more responsibility and carry out a particular assignment under only general supervision. Technicians may eventually move into supervisory positions. Those who have the ability and obtain additional education occasionally may be promoted to positions as scientists or engineers.

Employment Outlook

Employment opportunities for engineering and science technicians are expected to be favorable through the 1980's. Opportunities will be best for graduates of postsecondary school technician training programs. Besides openings resulting from the slightly faster than average growth expected in this field, additional technicians will be needed to replace those who die, retire, or leave the occupation.

Industrial expansion and the increasing complexity of modern technology underlie the anticipated increase in demand for technicians. Many will be needed to work with the growing number of engineers and scientists in developing, producing, and distributing new and technically advanced products. Automation of industrial processes and continued growth of new areas of work such as environmental protection and energy development will add to the demand for technical personnel.

The anticipated growth of research and development expenditures in industry and government also should increase requirements for technicians.

Related Occupations

Engineering and science technicians apply scientific principles in their work. Other occupations whose work activities involve the application of scientific principles include foresters, forestry technicians, range managers, soil conservationists, engineers, environmental, life, and physical scientists, broadcast technicians, drafters, surveyors, television and radio service technicians, dental laboratory technicians, and medical technologists and technicians.

(*This information was extracted from the U.S. Department of Labor Bulletin number 2200 Occupational Outlook Handbook, 1982-83 Edition.)

214

The following information was extracted from the U.S. Department of Labor Dictionary of Occupational Titles Fourth Edition, 1977.

GLOSSARY

ABSORPTION TOWER:
Tank used to form acidic bisulfate-active agent in digesting wood, from ingredients such as sulfur dioxide, lime, manganese, and ammonia.

ABTURATOR CUP:
See GAS CHECK.

ABUTMENT TOOTH:
Tooth used for support or anchorage of partial dentures.

AERATOR:
A machine (similar to a reel-type lawn mower with hollow spikes, rather than blades, bolted to the cut bars) used to extract cores of soil from lawn, allowing air, water, and fertilizer to penetrate soil.

AGATE BEARING:
A bearing made of agate used in small scales or precision balances where resistance to corrosion is essential.

AGE:
A process of steaming printed or dyed cloth to develop and fix color.

AIR LANCE:
A long metal rod that carries compressed air to its tip. It is used for cleaning purposes.

AIRGAP:
The gap between the rotor and stator of an electric machine.

AIRVEYOR:
See PNEUMATIC CONVEYOR.

ALODIZE:
A process for bathing metal in hot alodine solution to give it protective coating and surface for painting.

ALPHABETIC-NUMERIC:
The characters which include letters of the alphabet, numerals, and other symbols, such as punctuation or mathematical symbols.

ALPHANUMERIC:
A contraction of ALPHABETIC-NUMERIC.

ALVEOLOPLASTY:
Use of plastic in bony socket of tooth (alveolus).

ANAEROBIC DEVICES:
Instruments to remove oxygen from closed container or environment.

ANISEIKONIA:
Condition in which visual images appear different in size and form, causing eyestrain.

ARM BED:
A tube mounted horizontally above sewing machine table. Used to sew articles of concave or tubular shape. Also known as cylinder bed.

ARTICULATOR:
A hinged metal device on which plaster models of teeth and gums are mounted to simulate patient's mouth.

AUDIOLOGY:
The study of hearing and of hearing disorders.

AUTOMATIC DATA PROCESSING (ADP):
DATA PROCESSING performed by a system of electronic or electrical machines so interconnected and interacting as to reduce to a minimum the need for human assistance or intervention.

AUTOMATIC DATA-PROCESSING EQUIPMENT:
A machine or group of interconnected machines, consisting of INPUT, STORAGE, computing, control, and OUTPUT devices, which use electronic circuitry in the main computing element to perform arithmetic and/or logical operations automatically by means of internally stored or externally controlled programed INSTRUCTIONS.

AUTOMATIC DATA-PROCESSING SYSTEM:
The term descriptive of an interacting assembly of procedures, processes, methods, personnel, and AUTOMATIC DATA-PROCESSING EQUIPMENT to perform a complex series of DATA PROCESSING operations.

AVIONICS:
The science and technology of the development and use of electrical and electronic devices in aviation.

BACK GREY CLOTH:
Untreated fabric which is fed into fabric-printing machine between cloth to be printed and cylinder BLANKET to keep edges of latter and back of cloth clean.

BACK SHEET:
A veneer sheet, usually of slightly inferior quality than FACE SHEET, used for bottom surface sheet of plywood panels.

BACK-ROLL LATHE:
A veneer lathe equipped with knives mounted on impression roller that rotates counter to rotation of log. The knives score log lengthwise causing veneer to be peeled from log in narrow stave and hoop widths.

BAKER'S CHEESE:
A cottage cheese whose curd has not been cooked or cut, used to make cheese tortes or cakes.

BALANCE PISTON:
A disk placed on shaft of pump or compressor. Pressure is applied to one side to balance end thrust.

BALANCE WHEEL TRUING:
See TRUING II.

BALL MILL:
A large steel vessel within which steel balls are rapidly tumbled. Material admitted to mill is crushed by balls and discharged through sifting screens at bottom.

BALL WARP:
An untwisted rope of yarn wound on core, usually for dyeing or mercerizing.

BANBURY MIXER:
A mixing machine, employing rotating paddles, which permits control over temperature of mixing batch through introduction of steam or coolants into coils within mixing chamber, or through electrical heating units. Commonly used in processing rubber or plastics compounds where chemical or physical changes are accomplished concurrently with mixing process.

BAND:
Two plies of rubberized fabric pressed together with ends joined to form endless strip used in building pneumatic tires.

BANKING:
Positioning of banking pins in a timepiece to limit the angle through which pallet swings so that ESCAPE WHEEL teeth will clear or let off pallet as it strikes pins. Overbanking results when one side of pallet fork rests against banking pin while ROLLER jewel rests against opposite side of fork, thus locking the escapement.

BASTING MACHINE:
A single-thread chainstitch machine that sews evenly spaced, easily removed stitches, used for temporarily holding garment edges or layers of fabric together in preparation for permanent sewing.

BAT I:
A fluffy layer which is composed of interlaced and matted strands of fibrous material used for filling or insulating articles such as mattresses or comforters.

BAT II:
A wooden spindle upon which felt stock, produced by GARNETT MACHINE, is wound.

BAT III:
Plate of steel or pressed grit on which pressed grinding wheel is placed for drying and burning in kilns.

BATTER CLAW:
A plaster form covered with felt cloth, attached to mechanical or hydraulic arm, used to spread clay on mold prior to jiggering operation.

BEAD:
The core of rubber-impregnated strands of steel wire that form base of pneumatic tire and engage rim of wheel to which it is applied.

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215

BEAM I:
A cylinder upon which yarn or fabric is wound for dyeing or other processing.

BEAM II:
A rounded board upon which hides are stretched to be cleaned of hair and flesh prior to tanning operations.

BEAMING KNIFE:
A two-handled concave knife blade, ground to fit curve of BEAM II, that is used to scrape hair and bits of flesh from hides or skins.

BEAT:
See IN-BEAT.

BEATING MACHINE:
A machine equipped with leather strips which, when revolving, beat loose hair, dust, and foreign matter from fur pelts.

BEATING-UP MOTION:
The third motion involved in weaving yarn into cloth.

BED CLAMP:
See CLAMP MACHINE.

BELL REAMER:
An expanding bit used to enlarge bottom of holes drilled to accommodate concrete pier footings. The conical shape of resulting hole anchors footing and serves as base for pier construction.

BENCH GRINDER:
A small grinding machine for shaping and sharpening cutting edges of tools. It consists of a motor, mounted on bench or floor stand, with grinding wheel at one or both ends of shaft.

BILGE:
The greatest circumference of a barrel.

BILGE OF STAVE:
The difference in width between ends and middle of a barrel stave.

BINDER:
Tobacco leaves used to hold the inner parts of cigars in place before they are wrapped.

BISCUIT PEG:
A handtool used to spread and press the powdered clay into cracks.

BIT:
That portion of a smoking pipe held in the mouth and which forms part of the stem. Both stem and bit are often termed bit.

BITE BLOCK:
A wax reproduction of a denture used to study relationship of jaws and arrangement of teeth.

BITTER:
A handtool used to cut tile to irregular contours.

BLADDER:
Heavy-walled rubber cylinder used in curing press to expand uncured tires into recesses of tire mold.

BLANKET:
A band of thick rubber running beneath cloth in cloth-printing machine. Its principal function is to support cloth being printed and to absorb excess dyestuff.

BLINDSTITCH SEWING MACHINE:
A machine equipped with a curved needle to sew stitches that do not penetrate the outer surface of fabric. Used for operations, such as hemming, lapel padding, and lining felling.

BLOCK:
A round piece of bronze with concave top used to facilitate the grinding of lenses on fine-grinding and polishing machines.

BLOCK DIAGRAM I:
A graphical representation of the hardware in a computer system. The primary purpose of a BLOCK DIAGRAM is to indicate the paths along which information and/or control flows between the various parts of a computer system. It should not be confused with the term FLOW CHART.

BLOCK DIAGRAM II:
A coarser and less symbolic representation than FLOW CHART.

BLOCKER:
One of a number of leather strips joined together for use as trimming for shoes.

BLOCKING MACHINE:
An electric stove equipped with a grill on which BLOCKS, pitch, and lenses are heated. On depressing a lever, hot pitch is forced onto block surface.

BOARD:
A sheet of varnished canvas, or a lightweight wooden board, upon which rubber slabs or parts are placed for transportation or storage.

BOARDING I:
The process of softening leather and developing the grain by rubbing the surfaces together.

BOARDING II:
The operation of shaping and drying hosiery on heated, metal, leg-shaped forms known as hosiery boarding forms or boards.

BODKIN:
A large needle with an elliptical eye to receive tape, ribbon, or yarn.

BOLSTER:
The center beam of railroad car truck assembly.

BOLT:
A block or section of a log.

BONNAZ:
Embroidery made with a sewing machine having a hand-controlled feed mechanism. A handle under the bed of the machine directs the circular foot, which feeds fabric under the needle. BONNAZ includes embroidered monograms, trim attached in elaborate swirls or curlicues, and openwork sewn on a temporary backing of chemically treated buckram.

BOOK I:
Pieces of uncured gum rubber or rubber-coated fabric placed between cloth pages or canvas sheets to prevent cohesion.

BOOK II:
A bundle of half-leaves of tobacco from which stems have been removed. These are separated into right- and left-hand books since cigarmaking machinery works tobacco from only one side of the leaf.

BOX BLANK:
The sides, ends, and bottom of a wire-bound box in process of manufacture.

BOX TOE:
The toe of a shoe that has been reinforced to maintain its shape and to give reasonable protection to the wearer. Steel, plastic, leatherboard, leather, or glue- or shellac-stiffened canvas are used as reinforcing materials. Reinforcing process is known as boxing.

BRAIL:
A net resembling a small purse seine operated by ropes and pulleys, used for dipping fish from nets and traps.

BREAKER:
A strip of loosely woven rubberized fabric applied to pneumatic tire before the tread is put on that distributes pressure when the tire is in contact with ground.

BROKE:
Paper discarded because of dirt spots, wrinkles, tears, holes, or other defects, and paper trimmed from rolls or sheets by cutting machines. Wet BROKE is taken off wet press of paper machine. BROKE is usually returned to beater for reprocessing into paper.

BULKING CELL:
A rectangular enclosure with an open top and hinged door used to compress tobacco into a bulk.

BUNCH:
Crushed or shredded filler leaves pressed together to form inner part of cigars, usually held in place by binder tobacco leaves which are rolled around them.

BURLING IRON:
A handtool similar to an ice pick with a slit in the pick end used to push yarn through fabric.

BURN PATTERN:
The path that a fire takes from point of origin to the outermost limit of the fire.

BUS BAR:
Metal conductor forming a common junction between two or more electrical circuits.

BUSHING:
Heat resistant metal device with 200-400 holes through which molten glass is extruded to manufacture fiber glass sliver.

BUTTON:
A steel cylinder used on knitting machine to keep links of PATTERN CHAIN from engaging and turning gears that activate shafts of machine.

BUY BOAT:
A boat operated to buy the catch (as of shellfish) from fishing boats at sea and bring the cargo in to market.

CAKE:
Synthetic thread piled into ring shape.

216
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CALENDER MACHINE:
A machine designed to finish cloth, paper, or rubberized fabric by applying pressure to heavy rollers, some of which are heated. Two to ten rollers are used and various combinations of pressure, heat, and speed produce a variety of finishes.

CALENDER ROLLS:
A set of rolls between which fabric receives final pressing during course of manufacture. Usually rolls are heated by steam.

CALENDERING:
An operation in the process of making rubber sheeting in which material is rolled to uniform thickness between rolls of CALENDER MACHINE.

CALIPER CHISEL:
A chisel attached to one leg of caliper used to turn wood to specified diameter on wood lathe.

CANT.
A log that has been slabbed on one or more sides.

CAP-LEAD ASSEMBLIES:
Metal cap with extending lead wire. Cap-lead assemblies are used in production of electronic units, such as resistors.

CAPSTAN:
Drum-shaped device located between twisting-head and takeup spool of stranding machine.

CARD:
A unit of PATTERN CHAIN used on JACQUARD LOOM. It is a cardboard strip with holes similar to those in player-piano roll punched in it.

CARD CLOTHING FILLET:
A long, narrow strip of foundation material studded with many fine, closely spaced, wire teeth.

CARDING MACHINE:
A machine consisting of cylinders of various sizes covered with wire teeth, used to prepare cotton, wool, and other fibers for spinning by removing impurities and arranging fibers approximately parallel. The CARDING MACHINE receives fiber as raw stock or LAP II and delivers carded fiber as ROVING.

CARROTING:
The brushing of furs with solution of hydrogen peroxide and nitric acid. This treatment opens sheaths surrounding each fur fiber and permits matting (felting) of fibers in subsequent operations.

CASE CLAMP:
See CLAMP MACHINE.

CASING FLUID:
A flavoring solution applied to tobacco to give it distinctive taste. Usually made according to carefully guarded plant formulas from ingredients, such as tonka beans, rum, licorice, and sugar.

CAUL:
A sheet of wood, metal, or other material placed between layers of glued material in press to distribute pressure uniformly and protect facings of material from extraneous glue.

CAUSTICIZE:
To make caustic, especially to convert an alkaline carbonate into a hydroxide by the use of lime.

CAUSTICIZER:
Tanks used to convert spent liquor and lime hydrate into hydroxide.

CHAFER:
A strip of rubberized fabric that covers BEAD section of tire to protect plies which cover BEAD, from rubbing against metal rim of wheel.

CHAINSTITCH SEWING MACHINE:
A machine that sews a stretchable stitch, forming a chain of loops on the undersurface of fabric. There are two basic types: single-thread and multithread. The single-thread chainstitch machine sews with one thread per needle. The thread loops over itself to form an easily raveled chain. The machine is used for basting and for sewing where stretchability is needed. The multithread chainstitch machine sews a ravel-resistant chain by linking each needle thread with a looper thread. It is used where both stretchability and durability are required. Machines have from one to thirty or more needles.

CHAIR CLAMP:
See CLAMP MACHINE.

CHARACTER:
Any symbol, such as a digit or letter that is stored or processed by a computer.

CHARGER:
A cylinder, open at both ends, which is inserted in top of hogshead container to extend height of hogshead container for packing purposes.

CHARGING MANIFOLD:
A hollow pipe fixture containing holes which receive and hold capillary tubes of thermostat bellows while they are being filled with gas.

CHEESE:
A yarn package on which many short lengths of yarn have been combined into one continuous strand for more efficient use on machines, such as warpers or twisters.

CHEESE TRIER:
A long U-shaped cutting knife used by graders to remove sample plug from cheese block.

CHILL-PROOF:
To stabilize or eliminate protein compounds in beer to prolong shelf life.

CHOKER:
A noose of wire rope hitched about a log by means of which logs are skidded overground.

CHUCKING MACHINE:
A type of single- or multiple-spindle lathe equipped to hold individual workpieces in chucks.

CIAIO:
A type of counter-forming liquid which hardens when dry to give rigidity to back of shoe.

CLAMP MACHINE:
A stationary hand-powered or air-driven vise used to force together and hold joints of wooden assemblies in position while being reinforced by nails, screws, staples, and glue. Also known as CASE CLAMP, CHAIR CLAMP, or BED CLAMP, depending on design or purpose.

CLAMSHELL DREDGE:
A heavy steel bucket, divided into two parts hinged at top, fitted to derrick and controlled by cables. It is used to dig earth and gravel in construction work.

CLARIFIERS:
A machine having submerged, rotating arms with plow blades which scrape settled silt from bottom of settling basin spirally toward center of machine where silt is collected in trough and sluiced through pipes back to river. The clarifier does not clarify in the usual sense; silt is settled by gravity.

CLEARER ROLLER:
A small cloth- or felt-covered roller driven by frictional contact with rollers to keep rolls clean and collect ROVING waste when end breaks.

CLINCHING TOOL:
A device used to secure upholstery padding material to furniture frames. Wire staples held in tension in shaft of tool are released when trigger is pressed and secure padding material to frames.

CLOTH BEAM:
A spool 4 to 6 feet long on which cloth is wound as it is produced on loom.

CODE I:
A system of symbols for representing data or instructions in a computer or a tabulating machine.

CODE II:
To translate the program for the solution of a problem on a given computer into a sequence of MACHINE LANGUAGE or PSEUDO INSTRUCTIONS and addresses acceptable to that computer.

COIL FORM:
Paper or plastic tube onto which wire coils are wound. Forms vary in length according to number of coils wound on each form. Multiple wound coil forms are cut on bandsaw into individual coils for assembly into electronic equipment.

COILER HEAD:
An attachment on textile machines that coils sliver after it has been processed.

COLD TYPE:
Typesetting by means of office machines without use of metal type or 'slugs'.

COLOR BOX:
Metal trough under each PRINTING ROLLER that contains a reservoir of printing paste. A rubber or nylon bristle-covered roller dips color paste from COLOR BOX and forces paste into engravings of PRINTING ROLLER.

COMB:
Precut undipped pasteboard resembling a hair comb, used for book matches.

217 BEST COPY AVAILABLE

COMBER BOARD:
Board extending full width of warp and located above warp threads. It is pierced with small holes and serves to keep harness cords in order, one passing through each hole.

COMMUTATOR HUB:
Metal structure used to support a commutator.

CONE:
A tapered cardboard on which thread or yarn is wound.

CONES:
A set of small triangular pyramids of clay mixtures and fluxes so graded that they represent series of fusion points. The degree of heat is measured in kiln by observing which of various cones have bent over.

CONFIGURATION:
A group of machines which are interconnected and are programed to operate as a system.

CONSOLE:
A portion of the computer which may be used to control the machine manually, correct errors, determine the status of machine circuits, registers, and counters, determine the contents of STORAGE, and manually revise the contents of STORAGE.

CONTACT PROCESS:
Catalytic method of producing sulfuric acid by treatment of sulfur dioxide with catalytic agents and reaction of resulting product with water in absorbing towers.

CONTINUOUS MINER:
An electric hydraulically operated machine that cuts, loads, and conveys coal from coal seams onto belt conveyors or shuttle cars.

CONTROL PAPER:
A narrow ribbon of paper that is perforated by operation of keyboard to correspond to various sizes and styles of type. The perforated ribbon is then inserted in another machine wherein compressed air passing through perforations performs selection of matrices and casting of type metal in the matrices.

COP:
A paper tube on which yarn is wound; also quantity of yarn wound on a cop.

COPE:
Upper section of FLASK or PATTERN.

CORDEDGE:
A strip of bias-cut cloth folded over cord and sewn to form trimming used in edging wearing apparel.

CORE:
A shaped, hard-baked cake of sand that is placed within a MOLD to form the interior of hollow castings.

CORE BOX:
A wooden MOLD for making CORES. Molding sand is packed tightly into the CORE BOX. The box is then opened and the CORE removed.

CORE CUTTER:
A modified pneumatic pavement breaker (jack-hammer) adapted to break into wall of cement building.

CORE STOCK:
Cheap veneer sheets placed between glued CROSSBANDS to form interior of plywood panel between FACE SHEETS and BACK SHEETS.

COUNTERBORING:
A machining process in which an enlarged, flat-bottomed cylindrical hole is made at opening of existing hole usually so that bolt head or nut can be seated flush with or below surface.

COUNTING GLASS:
A small magnifying glass mounted over square-inch frame used to count mesh of wire cloth.

COVER MAT:
A square or rectangular mat formed by stapling two thicknesses of veneer staves together. Mats are subsequently cut into circular basket covers or lids.

COVERSTITCH SEWING MACHINE:
A machine that sews parallel rows of stitches with a covering thread spread between the rows on one or both surfaces. Used for coverstitching on knit fabrics.

CRACKS:
The outer grooves cut in buhr stones.

CREEL:
A rack holding spools or CHEESES from which yarn is drawn in weaving, knitting, beaming, spinning, or other related textile processes.

CRIMPING ATTACHMENT:
Two feed rolls and a stuffer box into which yarn is overfed, then folded or bent at a sharp angle and then heat-set during compression by attached heating element.

CROSSBANDS:
Cheap veneer sheets glued between CORE STOCK and surface veneer to form plywood, with grain of CROSSBANDS running across grain of CORE STOCK and surface veneer to bind and hold veneer sheets from expansion and warping.

CROZE:
Slots or grooves in staves of wooden barrels, hogsheads, kegs, buckets, tanks, or tubs, into which the heads of the vessels are fitted.

CUP:
Similar to SPREADER PAN in which it sets. Spreads molten lead around spreader pan through holes in side. Receives lead as it comes from spout.

CURING OVEN:
A loop or roller-type drier through which resin treated fabrics are run in open width at high temperature to convert soluble resin into insoluble compound.

CUTLINES:
Outlines of shapes of glass to be followed for cutting and leading stained-glass windows.

CUTTER CHANGE POINT:
A point, expressed in three dimensional coordinates, at which cutting tool of automatic machine tool changes direction.

CUTTERHEAD:
A rotating tool holder into which blades are clamped. It is used in machine tools in which rotating cutting tools are employed.

CYLINDER SCALE:
Same as FAN SCALE, except the reading face is essentially a rotatable cylinder on horizontal axis.

DATA PROCESSING I:
The preparation of source media which contain data or basic elements of information, and the handling of such data according to precise rules of procedure to accomplish such operations as classifying, sorting, calculating, summarizing, and recording.

DATA PROCESSING II:
The production of records and reports.

DEBEAKING:
Removing the tip on bird's upper beak to prevent infliction of injuries to other birds.

DEBUG:
To diagnose and correct computer malfunctioning or mistakes in programing.

DECANTER:
A rectangular, steel tank in which tar and ammonia are separated by settling according to their differences in specific gravity.

DENT:
The space between two wires in REED of loom.

DEPHLEGMATOR:
A fractionating column attached to a still in which vapor from the still is partially condensed, liquifying a portion of the vapor which is richer in the higher boiling constituents than the original vapor. The condensate may be returned to the still to enrich the vapor coming from it.

DEVULCANIZER:
A machine used in treating ground scrap rubber with chemicals and steam to restore it as nearly possible to its original physical and chemical state for use as RECLAIM rubber.

DIAGRAM I:
A schematic representation of a sequence of SUBROUTINES designed to solve a problem.

DIAGRAM II:
A coarser and less symbolic representation than a FLOW CHART, frequently including descriptions in English words.

DIAGRAM III:
A schematic or logical drawing showing the electrical circuit or logical arrangements within a component.

DIAL:
A flat circular plate that rotates and presents parts to machine at prescribed intervals. The worker places parts on designated spots on dial.

DIAL INDICATOR:
A measuring instrument consisting of a feeler point and a clocklike dial. Also known as INDICATING GAGE.

218
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DIBBLE:
A pointed steel tool used to make cone-shaped holes in the ground into which the root-soil cone of seedling trees are planted.

DIP NET:
A hand-manipulated ladle-like net used to dip fish.

DIPPER DREDGE:
A floating dredging machine that excavates by means of a single bucket or dipper on an arm and boom.

DIVER NET:
Two anchored gill nets, the second net having smaller meshes to catch fish that pass through first net.

DIVIDING HEAD:
Milling machine attachment used to hold and rotate workpiece through predetermined arc on machine table to perform a sequence of machining operations.

DOBBER:
A device with serrated edge which separates strands of yarn and keeps them parallel.

DOBBY LOOM:
A loom usually used for weaving goods of a nonfloral pattern in which the interlacings are complicated.

DOCTOR:
A scraper blade that removes excess material from a roller or from sheet material that passes through the rollers. Also known as doctor blade.

DOG I:
A piece of metal secured to a base or stationary object against which wedges are driven to move large component parts into specified alinement during an assembly or erection operation.

DOG II:
A steel, toothlike projection, several of which are attached to a carriage knee and operated by a lever. They are used to secure the log to the carriage.

DOGS:
Heavy metal hooks, attached to chains or cables, which are inserted into drilled holes in quarried stone blocks to facilitate handling by crane.

DOLLY BLOCK:
A metal or wooden tool used to straighten dents in body surfaces of automotive vehicles. Tool is shaped to confonn to surface being repaired and is held against surface while opposite side is hammered to remove dents.

DONKEY WATCH:
A spell of duty on board ship when at dock to watch over auxiliary engines furnishing steam, light, and power.

DOP:
Metal tools, threaded on one end for attachment to lathe spindle or GIRDLING STICK, and cupped on the other end to which rough diamonds are cemented for girdling.

DOPPLER:
Radio equipment designed to indicate location of airplane without reference to a ground station and used primarily in transoceanic flights.

DRAFT:
The extent to which fibers are lengthened by roving. A draft of five means that the fibers have been drawn to five times their original length.

DRAG:
The lower section of a FLASK, MOLD, or PATTERN.

DRAW WORKS:
The supporting derrick and associated mechanical equipment used to raise, lower, and power the drill stem on rotary drills used in boring oil, water, and gas wells.

DRAWING-IN:
In weaving, the process of drawing the warp threads from the warp BEAMS I through the specified HEDDLE.

DRAWING-IN DRAFT:
In weaving, a plan prepared on design paper showing how warp threads are to be drawn through the HEDDLE to produce desired pattern. A DRAWING-IN DRAFT is prepared for all fancy patterns.

DRAWING-IN FRAME:
A rack on which harnesses are hung while warp ends are being drawn through HEDDLE eyes.

DRIFT PIN:
A tapered steel pin for alining rivet holes before inserting the rivet.

DRIP:
A tank located below level of gas mains, and connected to main by pipes, for the purpose of collecting condensed water, gas, and tars which must be drained from the main continually to prevent congestion and eventual rupture of the pipe. Capacities of the tanks vary from a few gallons to as much as 500 gallons.

DRIVEMATIC RIVETING MACHINE:
A machine equipped with work positioner and tape control that automatically performs drilling, countersinking, dimpling, and riveting operations on aircraft wing panels and fuselage sections.

DROP:
In a timepiece the distance ESCAPE WHEEL tooth moves between the time it is released by PALLET STONE until next tooth is locked by opposite stone.

DROP WIRE:
In textile machines, thin metal strip with an eye through which single strands of yarn are passed. If the yarn breaks, the wire drops to cut the electric circuit, thus stopping the machine.

DRYING CANS:
A machine used in textile mills to dry fabric. Several large heated drums, wide enough to accommodate one or two widths of cloth, are arranged in tiers. Cloth threaded through drums contact a large area of each and are rapidly dried.

DUMPING PIVOT:
A simple steel basket open at top and one side to accommodate ice freezing containers. The lower corner opposite open side is hinged to facilitate tipping and removal of ice block.

DWELL METER:
An electrical meter used to measure dwell or time interval between closing cycle of distributor points of automobile ignition system. Incorrect spacing of points results in improper dwell.

EDGE ROLL:
Rope-like roll of jute core covered with burlap used to build up edges of upholstered furniture before adding padding.

EDGER:
A machine that automatically cuts dovetail tongues and grooves in opposing lengthwise edges of boards, applies glue to the formed edges, and interlocks the tongues and grooves of adjoining boards to form panels. Also known as LINDERMAN MACHINE.

ELECTRICAL-DISCHARGE MACHINING:
Removal of metal through action of high-energy electric sparks on surface of workpiece.

ELECTRONIC DATA PROCESSING:
DATA PROCESSING performed largely by electronic equipment.

ELECTRONIC DATA-PROCESSING EQUIPMENT:
See AUTOMATIC DATA-PROCESSING EQUIPMENT.

ELECTRONIC DATA-PROCESSING SYSTEM:
The general term used to define a system for DATA PROCESSING by means of machines utilizing electronic circuitry at electronic speed as opposed to electromechanical equipment.

ENGINE LATHE:
The basic type of metal-machining lathe or turning machine, consisting essentially of a bed with a headstock and gearbox on one end, a tailstock (no turret) at the other, and a carriage, cross-slide, and toolpost in between.

ENVIRONMENTAL ENGINEERING:
The application of scientific principles and technical practices to the protection and optimum use of air, land, and water resources and the management of urban development leading to improvement in the health and well-being of people and their environs.

ESCAPE WHEEL:
Wheel of escapement in clock or watch that supplies power from mainspring. It is allowed to 'escape' from pallet at rate governed by balance wheel and thereby controls motion of train.

EXTENDER:
A white inert substance added to pigments and dyes to reduce color strength or give more body.

EXTRACTOR:
A device used to extract water from fabrics, knit goods, or other materials by whirling them within a rotating perforated drum at high speed; a centrifuge.

EYELET PLATE:
A crossbar attached to CREEL immediately in front of each row of spindles, perforated with same number of holes as there are spindles, that guide individual ends from packages on spindles to loom.

FACE SHEET:
A veneer sheet, of high quality and free from imperfections, used for top surface sheet of plywood panels.

219

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FACING:
A machining operation that is a form of turning in which the tool is fed at right angles to axis of workpiece rotation to produce flat surface.

FAILURE MODE AND EFFECT ANALYSIS:
Detailed listing of potential failures of critical parts and effects on total system operation.

FAKING DOWN:
A method of coiling and laying ropes, nets, and other linear materials in overlapping figure 8's so they will run out without tangling when pulled at one end.

FALLER:
A narrow metal bar set with one or more rows of sharp, pointed pins that comb through silver to blend and aline fibers.

FALLER WIRE:
A device on a mule-spinning frame to keep yarn under tension during winding and to guide it onto bobbins.

FALSE SELVAGE:
An extra layer of selvage woven on each edge of some looped pile fabrics. This selvage is formed by FLOATS inserted to hold loop pile during weaving. Both FALSE SELVAGE and FLOATS are removed after cloth is doffed from loom.

FALSE-TWIST SPINDLE:
A hollow spindle with small wheel mounted in its aperture used in manufacture of stretch yarn. Yarn processed through this spindle is commonly referred to as false-twisted yarn.

FAN SCALE:
An automatic indicating scale, usually price-computing counter scale, whose reading face is a fan chart.

FEASIBILITY STUDY:
A study undertaken to identify various areas of operation within an organization which appear to be susceptible to AUTOMATIC DATA PROCESSING so as to determine the possible impact of ADP within these areas in terms of operating economies or improved management efficiency.

FEATHERS:
See SHIMS.

FEDERAL STITCH TYPE:
A Federal government standard that establishes, defines, and illustrates the requirements for the types of stitches, seams, and stitching formations specified in government specifications for the fabrication of sewn items.

FEED CUPS:
A feeding mechanism on a sewing machine on which the needle operates horizontally. Two wheels or discs rotate in a horizontal plane to pull the material between them.

FEED DOG:
Knurled metal piece that intermittently feeds fabric material beneath needle of sewing machine.

FEEDER TUBE:
A clay tube clamped in orifice of FOREHEARTH to capture and hold gob of molten glass for delivery to bottlemaking machines.

FELL:
The edge of cloth nearest to REED as it is being woven in loom; consequently, the last few PICKS I which shuttle has drawn through.

FELLED SEAM:
A stress-resistant seam formed by joining overlapped, interfolded garment-part edges with two or three parallel rows of stitching.

FELLING STITCH:
A sewing stitch that does not completely penetrate the material in which it is made. Such stitching is used to fasten lining into garments so that the stitches do not show on the outside.

FERRULE:
A threaded metal ring to receive screw-in cap for sealing ice bag.

FESTOONS:
Two banks of evenly spaced rollers in FOUR-ROLL CALENDER used for accumulating fabric to maintain continuous operations while making roll changes and for taking up slack in fabric prior to CALENDERING.

FILING JIG:
A jig inserted in recessed area of wooden gunstock to facilitate filing, sanding, or scraping of adjacent areas.

FILLING:
The cross threads in woven fabric that pass over and under the warp threads.

FILLING BOBBIN:
A tapered spindle on which FILLING is wound. It is held in battery of loom from which it is automatically injected into shuttle when needed.

FILLING PILE FABRIC:
Fabric in which an extra set of FILLING yarns forms pile. Examples are corduroy and velveteen.

FILM FLAT:
A group of film negatives or positives positioned on transparent paper or vinyl which comprise page elements (text and illustrations) of magazine, book, or other publication, used in preparation of lithographic or photographic printing plates.

FILTER AID:
A substance, such as diatomaceous earth, used to increase effectiveness of filtration equipment.

FILTRACELL:
A siliceous material that absorbs impurities and clarifies oil pressed from corn GERMS.

FILTROSE:
A catalytic agent used in production of butadiene.

FINDINGS I:
A term applied to miscellaneous fittings, such as buttons, snaps, eyes, and ornaments that are sewed or otherwise attached to garments and shoes during manufacture.

FINDINGS II:
A term applied to unassembled parts of jewelry, such as links, enameled pieces, pin stems, catches, joints, earring clips, and necklace clasps.

FINGER BUFF:
Strips of buffing cloth used in manufacture of buffing wheels. These strips are attached to core of buffing wheel with LACING and form fingerlike projections.

FINISH:
A starchy compound applied to fabric to give it body.

FIRST-ARTICLE-CONFIGURATION INSPECTION:
Detailed physical inspection by customer and company of first part or assembly of given series for conformance with authorization change and engineering drawing.

FIXED BRIDGE:
A dental appliance that is permanently attached to natural teeth or roots which furnish primary support.

FIXTURE:
See JIG AND FIXTURE.

FLAGGING:
Dried strips of a marsh weed, such as cattail.

FLASH:
The ridge or line of excess material left on metal or plastic objects along the parting or closing line of mold. Also known as fin.

FLASK:
An open-ended box, divided into two or more sections, into which molding sand is packed to form a MOLD. Molten metal is poured in the MOLD to produce a casting.

FLAT:
One of many lattices in chain covered with fine wire and used on CARDING MACHINE to comb fibers parallel.

FLATLOCK SEWING MACHINE:
A feed-off-the-arm coverstitch machine that sews a flat, nonraveling seam by joining abutted edges with a top-and-bottom covering stitch.

FLIGHT FOLLOWING BOARD:
A board fastened to wall, ruled vertically and horizontally forming rectangular grid spaces, and used to post flight number, airplane number, and arrival times of flights.

FLITCH:
A four-sided section of log from which veneer strips are sliced.

FLOATS:
The portion of warp or FILLING yarn that extends over two or more adjacent strands of warp threads or FILLING PICKS to form design during weaving; or that passes through loops of looped pile fabric, such as corduroy, to hold loops in position during weaving.

FLOORS:
The concentric grooves cut near the center of buhr stone.

FLOW CHART:
Synonymous with process chart and flow DIAGRAM II. A graphic representation of the major steps of work in process. The illustrative symbols may represent documents, machines, or actions taken during the process.

220
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FLOWER NAIL:
A long nail with large head that is used as base to create intricate designs with icings.

FLOWMETER:
An instrument for indicating pressure, velocity of flow, and rate of discharge of gas or vapor (such as steam) flowing in pipe. Usually equipped with recording pen and chart.

FLUSHED COLOR:
A pigment from which water has been displaced by another liquid such as oil. Most of the water is drawn off top and the rest is removed by vacuum.

FLYER:
An inverted, U-shaped metal arm that twists the ROVING or sliver and guides it on the bobbin.

FOLDING BONE:
A thin strip of fish bone used to fold and press leather edges under.

FOLLOW BOARD:
See MOLDING BOARD.

FONT:
A complete set of photomatrices which may be made up of individual photomats for each character or all may be combined on a single plate or filmstrip.

FONTS:
Metal bands or strips, each containing a complete set of alphabet and other characters of a specified size and style of type, used as a printing element in a Varitype machine.

FOREHEARTH:
A tunnellike structure of fired brick which receives molten glass from melting furnace and maintains glass at uniform temperature for delivery to bottlemaking machines.

FORM BOARD:
A specified number of FORM STRIPS fastened together side by side with long bolts.

FORM STRIP:
An aluminum strip to which forms for dipping such items as balloons and gloves into latex are fastened.

FORM TOOL:
A cutting tool ground to specific contour in order to machine the inverse contour in workpiece.

FORMER:
A machine used to twist ROVING or yarn into strands to make rope.

FORMING CHUCK:
A metal block shaped to contour and attached to machine spindle which serves dual purpose of holding and rotating cylindrical workpieces and as forming die to shape workpiece to contour.

FORTRAN:
A programing language designed for problems which can be expressed in algebraic notation, allowing for exponentation and up to three subscripts.

FOTO MAT:
Linotype metal matrices with small film of letter in center.

FOUR-ROLL CALENDER:
A machine which coats both sides of fabric stock with rubber simultaneously and rolls sheets to specifications. Also known as Z-CALENDER.

FOXING:
A strip of uncured rubber or rubber-coated fabric placed around footwear at juncture of sole and upper to hold them together, improve appearance, and waterproof article.

FRAZING MACHINE:
A machine which guides briar block against cutters to duplicate preselected pipe shape. A clamp-fitted shaft and a cam follows a master model to shape shank and lower half of bowl.

FREENESS:
The quality of pulp stock that determines rate at which it parts with water when being formed into sheet on wire screen or perforated plate. The same quality is known as freeness, slowness, or wetness according to type of instrument used to estimate it.

FRENCH BINDING:
A narrow strip of fabric that is stitched to edge of shoe uppers and folded over to form smooth finished edge.

FRENOTOMY:
Cutting of mucous membrane under tongue.

FROTHING MACHINE:
A mixing machine with electrically operated agitating paddles used for mixing air with latex to obtain desired density.

FULLING MILL:
A machine that shrinks and felts fibers of woolen cloth through application of moisture, heat, friction, and pressure. May be used to crush and dust carbonized vegetable matter from dry woolen cloth.

FUR MACHINE:
A disk-feed sewing machine used for seaming heavy materials to make items, such as fur and fake fur garments, plush toys, and leather slippers. Layers of material are guided vertically between the two disks (cups or wheels) and sewn with a horizontal needle.

FURNISH:
The mixture of various materials, such as pulp, sizing, fillers, and dyes, from which paper is made.

GAGE BLOCKS:
Hardened steel blocks, each of a standard dimension, used as standards in precision measuring. Sometimes referred to by trade names, as JOHANSSON BLOCKS, or (in shop usage) JO-BLOCKS.

GAMB STICK:
A metal or wooden rod with pointed or hooked ends which are inserted through the tendons on the hind legs of animal carcass to hold the legs apart while animal is dressed. The stick has a rind in the center for attaching to a trolley or an overhead rail.

GANG KNIFE:
A set of knives, arranged to be raised and lowered by hand, used to slice fish into several pieces of predetermined length.

GARNETT MACHINE:
A machine similar to a CARDING MACHINE, used to open hard-twisted yarn wastes, rags, and clippings. Cylinders are covered with coarse wire teeth.

GAS CHECK:
A metal cup, coated with oil or wax, that expands to form a gastight, moving seal under piston of device used to measure pressure produced within gun barrel by exploding cartridge.

GEAR CAGES:
A cluster of gears, bearings, and locking devices usually attached to a shaft.

GEAR GENERATING:
A gear-machining operation in which the cutter teeth have (or simulate) the shape of mating gear teeth rather than of the space between the teeth, and the cutting is done as the cutter and gear blank rotate together.

GEL:
A heavy fluid containing solid materials, such as round-grained sand, walnut hulls, or aluminum pellets, and used, along with pressure, to fracture gas or oil-bearing rock formations.

GEL-COAT:
Pigmented, high purity polyester coating, catalyzed with liquid oxidizers used to form layer on boat mold prior to application of fiberglass resin layers.

GERM:
A term sometimes applied to the embryo which occurs in seed plants immediately after fertilization and then undergoes a resting period in the seed until germination takes place.

GIFT REGISTER:
A list of gifts already purchased for a bride and groom that is kept for the benefit of future wedding-gift purchasers to avoid duplicate gifts.

GIMP THREAD:
Heavy twinelike thread used to reinforce edges of buttonholes in heavier garments.

GIRDLING STICK:
A tool with one end threaded to hold DROP, wooden middle section for hand hold, and metal rod on the other end which is held between body and arm to support and control diamond during girdling.

GORE:
An elastic insert in side, front, or panels of a shoe used to decorate or reinforce, or to allow stretching that will provide additional comfort and freedom of movement to wearer.

GREIGE:
Untreated textile fabric as it comes from the loom or knitting machine, so called because of its gray, unfinished appearance.

GREY:
See GREIGE.

GRIZZLY:
A device consisting of a group of strong iron bars or revolving disks used to size broken rock or coal.

221 BEST COPY AVAILABLE

GROUND RACKING BOARD:
Wooden boards of various lengths and widths that are placed flat on oil well floor to form a base for tubing and pipe sections to stand on when sections are standing up-right in derrick. Boards are used for base to prevent sections from sinking into ground and getting plugged with soil or mud or to prevent damage to threaded ends of pipe and casing.

GROUND TACKLE:
The anchors, cable, and other gear used to secure a vessel at anchor or dock.

GUARD PIN:
Pin located below end of pallet fork in timepiece that acts as safety device against OVERBANKING by insuring that pallet is in proper position to receive ROLLER jewel.

HAIRSPRING TRUING:
See TRUING II.

HALF LAP:
Approximately half of a hollow, cylindrical shell on which are fastened 17 brass bars set with steel needles. The size of the needles and their spacing varies from bar to bar.

HALFTONE CUT:
A printed impression made from halftone plate.

HAMMER MILL:
A grinding mill that breaks up particles of material by impact of whirling bars (hammers) attached to rapidly rotating hub.

HAND:
The feel of textile goods as soft, harsh, smooth, rough, or boardy.

HANGER:
Part of bicycle frame that holds fork assembly.

HARNESS FRAME:
Two wooden laths upon which are suspended series of cords or wires called HEDDLES.

HARP:
Metal frame crossed horizontally or vertically with fine cutting wire to cut curd (coagulated or thickened part of milk) in vat or kettle to measured size.

HEAD:
Part of bicycle frame that holds crank and sprocket assembly.

HEADER:
A fabricated chamber to which series of tubes are joined to permit free circulation of fluid within water tube boiler.

HEDDLE:
A fiber or metal strand on HARNESS FRAME of loom through which warp threads pass.

HEEL-BOOM:
The boom of a log loading or sorting machine having a wide, flat underside or serrated plate behind the main sheave. One end of the log is heeled (lifted against) the boom or serrated plate, forcing the log into a horizontal position. The machine and boom are then rotated to position the suspended log over a log truck-and-trailer or log pile.

HELICAL SPRINGS:
Spiral springs used to hold rows of coil springs together in bedsprings.

HEMSTITCHING SEWING MACHINE:
A machine with a punch and an oscillating needle that punches a line of holes and sews a decorative stitch which secures each hole.

HIGH LEAD:
A cable-log yarding system consisting of a steel or wooden spar near the yarding machine and a circuit of cable running from the top of the spar to a block at the rear of the cutting area, which enables logs to be lifted over obstructions in rough, mountainous terrain where logging tractors cannot be used efficiently.

HOB:
A gear-cutting tool shaped like worm whose threads are interrupted with grooves to form series of cutting teeth.

HOBBING:
A gear-machining operation in which teeth are generated by rotating HOB and gear blank against each other with action similar to that of worm gear. See GEAR GENERATING.

HOG MILL:
A power-driven machine for cutting scrap wood into fine particles suitable for blowing as fuel into fireboxes or boilers with compressed-air jet.

HOMOGENIZED LEAF:
A tobacco wrapper material made from powdered tobacco and other substances that cause ingredients to stick together.

HOOKER MACHINE:
A machine that folds cloth by means of blade that guides fabric back and forth across surface of table.

HOOP NET:
A cylindrical (coneshaped) trap net of twine or wire mesh for catching fish that is open on one end and held in shape from within by several frames, usually hoops, one behind the other. One or more frames are covered with funnel-shaped mesh that opens toward the closed end.

HORN:
A device mounted on a unit similar to a sewing machine called an ULTRASONIC SEAMING MACHINE. HORN emits high-frequency sound waves that fuse thermoplastic materials.

HYDRO-SPRAYER:
A tank with horizontal-in-tank agitator, motor, pumps, and piping system, mounted on truck bed, used to cover areas, such as highway median strips, hillsides, and fields with mixture of grass seed, fertilizer, and mulch.

HYDROL:
A light-brown sirupy liquid formed in manufacture of dextrose.

IMPACT WRENCH:
A pneumatic wrench used to tighten or loosen nuts and bolts.

IMPULSE FACE:
Angular plane on end of PALLET STONE over which ESCAPE WHEEL teeth pass providing a lifting action in timepiece.

IMPULSE PIN:
The pin mounted on balance wheel of clock or watch that receives impulse from pallet fork.

IN-BEAT:
Characteristic of timepiece movement resulting from jewel pin being in line of center on ESCAPE WHEEL, pallet, and balance wheel when hairspring is unstressed. In this condition the strokes of the escape wheel teeth against PALLET STONES will occur at equal intervals. A timepiece is out of beat when strokes or ticks occur at unequal intervals.

INDEXING:
Moving workpiece or toolholding device, such as a turret, to a series of regularly spaced positions to repeat an operation or to perform a series of operations at predetermined intervals.

INDICATING GAGE:
See DIAL INDICATOR.

INPUT:
Information transferred from auxiliary or external STORAGE into internal STORAGE.

INSTRUCTION:
A set of computer WORDS or CHARACTERS that define the operation to be performed by a computer.

INVEST:
To cover, envelop, or surround wholly or in part an object, such as denture, tooth, wax form, crown, etc., with heat-resisting material (refractory material) before curing, soldering, or casting.

INVESTMENT:
A pastelike material used to maintain positions of metal parts during soldering or welding.

INVOLUTE CHECKER:
A device for inspecting involute curves on teeth of gears, splines, etc.

J-BAR:
A metal bar shaped as the letter 'J' with hook attached at both ends of bar used to transport logs from forest.

J-BOX:
A vertical tunnel or container, shaped like letter J, used in wet-cloth finishing operations to make process continuous.

JACQUARD LOOM:
Loom equipped with device for weaving figured fabrics. The Jacquard attachment consists of mechanism controlled by perforated CARDS which cause warp threads to be lifted in proper succession for producing figure.

JIG:
See JIG AND FIXTURE.

JIG AND FIXTURE:
Frequently the terms JIG and FIXTURE are used interchangeably. More precisely, JIG is defined as a device that holds work in position and also guides tools acting upon the work; while FIXTURE is considered as a clamping device with no provision for guiding tools.

JIGGER:
Small pointed metal instrument, resembling sharpened pencil, used in assembling ribs of expansion metal watch bands.

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222

JO-BLOCKS:
See GAGE BLOCKS.

JOHANSSON BLOCKS:
See GAGE BLOCKS.

JOLLY:
An apparatus similar to a jigger by which plastic clay is formed into pottery, such as cups, urns, and planters. The shaping tool, suspended from cable with pulley and counterweight in upright support, shapes inside of ware.

JUMP IRON:
A heavy iron, supported by movable arm, designed to eject steam through holes in bottom. A pedal is depressed to lower iron and to apply pressure to article being pressed. The iron is pushed back and forth manually.

JUMPBASTING SEWING MACHINE:
A basting machine that allows free movement of fabric over the work bed to produce a stitch of variable length and direction. There is no feed mechanism or presser foot. A plunger-like device (needle stripper) encloses the needle and holds the fabric down only long enough for the needle to penetrate and withdraw. Used for basting with a long, loose stitch over large areas to hold plies of fabric together, as in preliminary positioning of coat layers.

KAPLAN:
A control for water turbines which varies pitch of blades in accordance with load, resulting in high efficiency over large-load range.

KEYSEATS:
Slots or recessed grooves in shafts. One-half of a key fits into the shaft keyseat, while the other half fits into the hub keyway preventing a gear or pully from rotating on a shaft.

KNOTTER:
A device that ties two threads and clips loose ends in one operation. May be strapped to hand or around wrist. On automatic spoolers or winders KNOTTER is part of machine and yarn is drawn into KNOTTER by vacuum.

LACING:
A circular metal strip with serrated edges used in manufacture of buffing wheels to secure buffing material to center of wheel. The serrated edges are bent outward to form groove in which material is inserted.

LADDER DREDGE:
A floating dredging machine that excavates by means of a series of buckets on endless chain.

LAG BOLT:
A lag screw, a screw with wood-screw threads on one end and tap-screw threads or wrench head on other end.

LAMPARA NET:
A net, with cork floats attached to top and lead weights attached to bottom, that forms a bowl-shape when towed along surface of water to catch fish.

LANDING:
A cleared area of land at a logging site where logs are brought by tractors or yarding machines and loaded onto trucks.

LAP I:
A tool, usually of softer material than workpiece and of complementary shape, which is charged with LAPPING COMPOUND. See LAPPING.

LAP II:
A roll of loosely matted cotton fiber.

LAP III:
A horizontal wheel or disk made of cast iron, used to fine-grind flat surfaces on diamonds or other stones.

LAP-UPS:
A term used in textile industry denoting material (lap, thread, fibers, etc.) which becomes entangled in or wound about machinery.

LAPPING:
Smoothing, finishing, or achieving an extremely close tolerance (e.g., 0.000002 inch in gage block manufacture) on metal surface by means of a LAP that is charged with LAPPING COMPOUND and rubbed against workpiece in rotary and/or reciprocating motion, either by hand or machine. Matching workpieces may be lapped against each other to assure a close fit. Sometimes used loosely to denote fine grinding or honing.

LAPPING COMPOUND:
A fine abrasive flour, usually mixed with oil, water, or some other vehicle in the form of paste, which becomes imbedded or 'charged' in the LAP. See LAPPING.

LASTING:
The operation of tacking a shoe upper and insole to a last or of turning down and sticking together the upper and sole of rubber footwear by hand or machine.

LASTING TOOL:
A combination handtool usually composed of hammerhead, pincers, and tack puller used in construction of shoes. Also known as lasting pincers or shoemaker's pliers.

LATCH NEEDLE:
A knitting-machine needle, the hook of which can be closed by a latch pinned to shank of needle. When latch is closed, the needle, carrying yarn, may be drawn through loop to form a chainstitch.

LAUTERTUB:
A closed, insulated tank containing cutting-raking device, metal filter, and sprinkling device used in beer manufacture to withdraw clear wort from grain mash.

LAY:
A number of layers of material, each layer being placed on the layer beneath, with corners and edges in coincidence.

LAYBOY:
An automatic mechanism that receives, stacks, and jogs sheets of paper into piles. It may be attached to machines, such as cutters, printing presses, or ruling machines. Generally equipped with counting and tabbing devices.

LAYOUT MACHINE:
Modified vernier height gage, having a scriber on the end of an extending arm, which when positioned next to workpiece, scribes exact locations of reference points and lines.

LEACH TANK:
A tank containing hot water into which uncured balloons are dipped to remove bitter taste of coagulant.

LEAD WIRES:
Soft metal wires used to take impressions between two adjoining parts to determine clearances measured by micrometers.

LEADER:
A piece of fabric or other material, attached to one end of cloth or yarn that serves to pull and guide it through a machine at the beginning of a textile operation. In the garment industry it is a long strip of celluloid with hole at one end for insertion of safety pin into elastic tape to facilitate pulling tape through hem channel.

LEASE:
The method of arranging and retaining strands and skeins in an orderly fashion to prevent tangling during processing and weaving.

LEASE ROD:
A long oval rod, usually of wood, inserted between the threads of a warp to form a LEASE.

LEASE STRING:
Strings inserted between the threads of a warp to hold the threads in the same relative position for DRAWING-IN or tying to old warp.

LEHR:
A tunnellike oven containing heating and cooling elements through which materials such as glass are conveyed for heat-conditioning and slowly and evenly cooled to eliminate internal stresses.

LET-OUT PELT:
Fur pelt cut into diagonal strips and resewn to make pelt longer and narrower and to improve its quality and appearance.

LETOFF PACK:
A rack that operates with braking action permitting machine to pull material from a roll.

LEVER:
In a scale, a part provided with pivots or plate fulcrums for translating external forces.

LIGHT TABLE:
A table or bench having translucent top over a light source. It is used in examining objects where it is desired that no shadow will be cast.

LINDERMAN MACHINE:
See EDGER.

LITE:
Flat glass cut to specified size from continuous sheet of glass.

LOAD:
Amount of force needed to compress or extend a spring to a given height or length.

LOADING BOX:
A receptacle, usually part of or rigidly attached to a lever into which molten metal or equivalent may be poured to aid in balancing scale under a zero load.

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223

LOCK; LOCKING FACE:
In a timepiece the extent of overlap between ESCAPE WHEEL tooth and PALLET STONE. Locking face is that side of pallet stone against which escape wheel tooth locks.

LOCKSTITCH SEWING MACHINE:
A machine that sews a stitch identical on both surfaces, needle and bobbin threads linked between the surfaces. Used where a non-raveling, non-stretching stitch is needed. The single-needle lockstitch machine is the machine in common use for most sewing operations, but there is also a two-needle lockstitch machine, used mainly for topstitching.

LOOM BEAM:
A large wood or metal cylinder on which are wound the warp threads for a loom.

LOOPER:
A sewing-machine mechanism that forms loop in thread, through which needle passes to make a chainstitch.

LOOPING LINE:
A line of stitches knitted into both sides of the open toe of seamless hose as a guide along which the looper must set the stitches to produce a straight looped toe.

LOOPING MACHINE II:
A machine that knits two parts of knitted garment or stocking together.

LOOPING MACHINE I:
A machine that forces ends of helical springs around die to form a hook so that springs can be linked to other bedspring parts.

LUMBER SCALE:
A ruler equipped with a calibrated scale used to measure width of rough-sawed lumber of known thickness and length and to convert measurement into board feet.

LUMITE:
A liquid which hardens when dry to give rigidity to back of shoe.

MACHINE LANGUAGE:
See MACHINE ORIENTED LANGUAGE.

MACHINE ORIENTED LANGUAGE I:
A language designed for interpretation and use by a machine without translation.

MACHINE ORIENTED LANGUAGE II:
A system for expressing information which is intelligible to a specific machine, e.g., a computer class or of computers. Such a language may include instructions which define and direct machine operations and information to be recorded by or acted upon by these machine operations.

MAGNETIC TAPE:
A continuous flexible recording medium whose base material is impregnated or coated with a magnetic sensitive material ready to accept data in the form of magnetically polarized spots.

MAKE-OVER:
In newspaper work, subject matter that is to replace copy on newspaper pages to make a new edition.

MASER (MICROWAVE AMPLIFICATION BY STIMULATED EMISSION OF RADIATION):
A device which subjects molecules or atoms of a paramagnetic material to a microwave signal which triggers release of radiation.

MASK MIRROR:
A glass plate, with silvered images of facial features imprinted, used to block out portions of a photograph in preparing a montage.

MASTER:
Copper negative electroplate made by electrodeposition on original lacquer recording disk on which a record has been made. Required in making STAMPER, which presses positive of recording into phonograph records.

MASTER STRAIGHTEDGE:
A straight slender bar made of rigid material, which is placed across wide points of contact to hold the level on a structure to be leveled.

MAT BOARD:
A cardboard material with a dull finish on one side, used for picture borders. It is prepared in white and tinted finishes.

MATCH PLATE:
A wooden or metal plate with half a PATTERN attached to each of its sides. Each half of the PATTERN is used to form one-half of a casting, with the MATCH PLATE resting on the edge of the FLASK.

MATHEMATICAL MODEL:
The general characterization of a process, object, or concept, in terms of mathematics, which enables the relatively simple manipulation of variables to be accomplished in order to determine how the process, object, or concept would behave in different situations.

MEASURING WIRES:
Accurately made short wires of standard diameters, for use in precision measuring of gear or thread dimensions.

MECHANICAL PRINT:
An engineering drawing that is the actual pictorial presentation of a product, part, or machine, showing dimensions, type of material, wiring, and other details.

MEGGER:
An instrument used to measure insulation resistance or electrical resistance of electrical equipment, such as powerline poles.

MEMORY:
See STORAGE.

MENDING DISK:
An electrically powered mending device containing wire or plastic fingers that revolve rapidly to pull picked or pulled threads into position on hose.

METALWORK:
The skeletal portion of a dental appliance around which and to which are attached the remaining portions of the appliance to produce the finished unit.

MILANESE FABRIC:
A highly run-resistant fabric in which the yarn runs diagonally across face of fabric. The fabric is usually made into gloves and underwear.

MILIEU THERAPY:
Method of treatment in which interaction of patient and environment are utilized.

MILL:
A small, soft-steel cylinder upon surface of which a design in relief is made by rolling in contact with die.

MILLING CUTTER:
A multiple-toothed or fluted disk or cylinder that shaves the surface of a workpiece as it is rotated in contact with the material.

MINERAL WOOL BLANKET:
A continuous ribbon of mineral wool fibers, 2 to 4 inches thick and up to 10 feet wide, that is cut into insulation batts and felts.

MOLD:
A form, made of sand, metal, or other material, in which anything is cast.

MOLD-PRINTING BOARD:
The board on which molds are fixed in rows and which, when placed upside down over a tray of leveled starch leaves indentations into which fluid candy is introduced.

MOLDING BOARD:
A board on which the PATTERNS and DRAG are placed when making the DRAG part of a MOLD. Also known as FOLLOW BOARD.

MONOTUBE:
A hollow stainless-steel tube, into which enriched uranium fuel elements are loaded.

MORTAR GUIDE:
A metal band that fits the edge of a stone and has a projecting side the thickness of a joint.

MOSS:
A form cadmium metal takes when the molten metal drops into cold water. This bubblelike form of solidified metal enhances dissolution.

MOTHER:
Nickel positive electroplate made by electrodeposition on MASTER electroplate. Required in making STAMPER, which presses positive of recording into phonograph records.

MUFFLE FURNACE:
A closed furnace designed so material may be placed in it, yet not come in direct contact with the fire.

MULLING:
The process of heating tobacco to ferment and sweat out bitter gums, ammonia compounds, and impurities which impair flavor and color of tobacco leaves.

MULTIMETER:
A meter used to test electrical or electronic circuits that serves as an ammeter, ohmmeter, voltmeter, and other test meters in a single unit.

NARROWING:
The process of contracting size of knit articles, especially a stocking, by taking two stitches in one.

NECK RING:
A cast iron ring which is used in conjunction with mold to form neck of bottle.

224
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NECKTIE-CENTRALIZING SEWING MACHINE:
A machine that sews the lengthwise seam on a necktie. Two types of machines are in use: One is equipped with a hook in front of the needle and another under the bed of the machine to assist in forming an unusually stretchable single-thread stitch. The other is equipped with a feed track resembling a tractor tread in appearance, that pulls fabric edges up and down over a stationary, 35-inch, horizontal needle to simulate handstitching.

NEEDLE:
One of a set of parallel slender rods or wires fitted into slotted metal bar used in knitting to hold stitch formed by SINKER ..

NEEDLE BAR:
A slotted metal bar in which knitting needles or points are inserted and clamped to plates that hold them in position in knitting machine.

NEEDLE BOARD:
A long, narrow board into which are set hundreds of needles to punch bits of felt between threads of burlap or other textile.

NEEDLE JACKS:
Small metal pieces, fitted into grooves in needlebed of knitting machine, that transmit reciprocating motion to needles.

NEPS I:
Little knots in cotton fiber formed by irregular growth of plant or by friction in process machinery.

NEPS II:
Minute, tangled masses of cotton, wool, or synthetic fibers.

NOTAMS (NOTICE TO AIRMEN):
A notice or report to inform flight crews of hazards in flying and landing aircraft and changes in condition of navigational aids or landing facilities.

NUMERICAL CONTROL:
A system of automatic-machine operation in which product specifications are translated into numerical-machine instructions which are recorded on cards or tape (punched or magnetic) and transmitted through control unit to the machine, so that it automatically performs specified operations, often verifying results and making corrective adjustments automatically.

OCCLUSAL HARMONY:
The occlusal relationship of opposing teeth in all functional ranges and movements that provides greatest masticatory efficiency without causing undue strain upon supporting tissues.

OFF-LINE:
Pertaining to the operation of INPUT-OUTPUT devices or auxiliary equipment not under direct control of the central processing unit.

ON-LINE:
Pertaining to the operation of INPUT-OUTPUT devices under direct control of the central processing unit.

OPTICAL FINISH:
The quality of surface of lens after scratches and pits have been polished out. The optical finish is determined by inspecting lens under magnifying glass.

OPTICAL FLAT:
A tool made from transparent material, such as fused quartz or glass, whose surface is polished to be a true plane within tolerance of millionths of an inch. Used as precise measuring gage of flatness of surfaces by reflection of monochromatic light.

OPTICAL SCANNER:
A device that automatically samples or verifies a number of measuring points and indicates those that have drifted from their desired values.

ORDER:
To condition tobacco for handling by subjecting it to steam or water.

ORDERING MACHINE:
A machine in which tobacco is brought to desired moisture content by application of water or steam spray in cylindrical device or compartment through which conveyor belt passes.

OUTFLOW QUENCH STICK:
A device on spinning machine that quenches (cools) formed synthetic filaments upon ejection from spinnerette.

OUTPUT:
Information transferred from internal STORAGE to external STORAGE or to an ON-LINE OUTPUT device.

OVERBANKING:
See BANKING.

OVERBURDEN:
Overlaying earth and rock deposits which cover coal, ore, or rock in strip mine, open pit, or quarry.

OVERCOIL HAIRSPRING; OVERCOILING:
Hairspring of a watch with its outer coil raised above plane of spring and then bent so as to terminate in a curve that is concentric with remaining coils. Purpose is to provide for concentric winding and unwinding of spring thereby eliminating side thrust against bearings. Overcoiling is the act of bending outer coil.

OVERLOCK SEWING MACHINE:
A machine that sews an overedge stitch, looping over fabric edges to prevent edge fraying or to seam two or more plies.

PACK:
An assembly containing a spinnerette, filter screen, gaskets, and sand through which polymer is passed to filter out impurities and form filaments by forcing polymer through spinnerette.

PACKAGE DYEING MACHINE:
A dyeing machine resembling large pressure cooker. The yarn to be dyed is wound on perforated beams or tubes so that dye solution can be circulated through package.

PAGODA:
A removable assembly of cone-shaped steel troughs placed inside a retort to provide greater heating surface for sublimation of magnesium.

PALLET:
A metal fixture weighing over 100 pounds that holds workpieces as they are machined in transfer machine. It rides on track from which it is never removed and is lifted into position at each work station by hydraulic pushers.

PALLET STONES:
Jewels in pallet of watch which provide a hard, smooth surface on which teeth of escape wheel act.

PALM:
A piece of leather or heavy canvas worn in the palm of the hand, to prevent injury as a needle is pushed through heavy material.

PANTOGRAPH MECHANISM:
An attachment used with conventional metal cutting machines, which allows for two (or three) dimensional duplication of a template. The exact or scalar movements of the tracer spindle over the template is transmitted to the cutter spindle which cuts the template pattern from a blank.

PAPER TAPE:
A strip of paper capable of storing or recording information. STORAGE may be in the form of punched holes, partially punched holes, carbonization or chemical change of impregnated material, or by imprinting. Some PAPER TAPES, such as punched PAPER TAPES, are capable of being READ by the INPUT device of a computer or a transmitting device by sensing the pattern of holes which represent coded information.

PARAMETER I :
A quantity in a SUBROUTINE whose value specifies or partly specifies the process to be performed. It may be given different values when the SUBROUTINE is used in different main ROUTINES or in different parts of one main ROUTINE, but usually remains unchanged throughout any one such use.

PARAMETER II:
A quantity used in a generator to specify machine CONFIGURATION, designate SUBROUTINES to be included, or otherwise describe the desired ROUTINE to be generated. continuous data.

PARAMETER III:
A constant or a variable in mathematics which remains fixed during some calculation.

PARAMETER IV:
A definable characteristic of an item, device, or system.

PARTICLE BOARD:
Boards made from resin-bonded wood chips used as lumber substitute.

PATCHBOARD:
A component of some DATA PROCESSING machines which permits the expression of INSTRUCTIONS in a semifixed computer program by the insertion of pins, plugs, or wires into sockets or hubs in the components in a pattern to represent INSTRUCTIONS and thus making electrical interconnections which may be sensed by the DATA PROCESSING machine.

PATTERN:
A form used in the molding and casting of metal objects.

PATTERN CHAIN:
The part on textile or sewing machines that controls certain machine actions to produce desired pattern, color, shape, size, or novelty effect. On DOBBY LOOMS and knitting machine, the chain is made

225

of joined metal links or pegs; on JACQUARD LOOMS, it consists of perforated cardboard strips joined by cords; on embroidery machines, it is a perforated strip.

PENCIL EDGE:
The round or convex surface edge of glass or mirror after edges have been ground. To apply such edge by grinding.

PERIPHERAL EQUIPMENT:
The auxiliary machines not under the control of the central computer.

PICAROON:
A short-handled device with pointed metal end used to move and aline logs and lumber inside a sawmill or in confined areas.

PICK COUNTER:
A device containing magnifying lens and pointer, used in counting threads per unit space and in other ways in examining cloth.

PICK I:
One thread of FILLING either before weaving or in cloth. Number of picks per inch of warp is measure of fineness of fabric.

PICK II:
A short metal rod tapered to a point and mounted in wooden handle, resembling an ice pick, used by wire weavers to pick up and reweave broken wires.

PICKING MOTION:
The second of three basic motions involved in weaving yarn into cloth. The motion resulting from mechanism of loom that propels shuttle from one side of loom to the other.

PICOT BAR:
A bar on knitting machine that holds slender metal rods (picot points) used to knit a row of large, wide stitches (picot stripe) after welt is knitted.

PIECE UP:
The joining or union of two or more ends of sliver, slubbing, ROVING, or yarn by twisting or intermingling fiber ends with fingers.

PILE WIRES:
Strips of metal that are inserted into SHED of looms to form pile fabrics, such as carpeting.

PILLAR PLATE:
Base plate which determines size and shape of clock or watch movement. It is recessed and drilled to form foundation for assembly of various parts and pivots which comprise movement.

PIN BRIDGE:
Similar to PIN GAGE PLATE except that plate is mounted in bridgelike FIXTURE. The plate of cartridges is set in FIXTURE and raised by treadle action against PIN GAGE PLATE.

PIN GAGE PLATE:
A plate containing rows of equidistant free-floating pins. The pins are inserted in cartridges and are pushed up by powder in cartridges, or remain down if any cartridge has been skipped.

PIN JACK:
A cast iron pedestal, usually fastened to shoemaker's bench, on which shoe last is placed during processing operations.

PINCH CLEAT:
A metal cleat that fits around ends of steel bailing straps. When pinched by strapping tool cleat secures ends and keeps strap taut on bale.

PITCH FINGER:
A metal rod mounted over journal of mill that is used to pitch design on mill in register with other portions of design during engraving process.

PITCHED WORT:
Wort (unfermented beer) with added yeast to promote fermentation.

PIVOT:
That element of conventional scale LEVER designed to transmit external forces through its knife edge.

PLANER GAGE:
A work aid consisting of two right-triangle ground metal blocks fastened together to enable user to adjust their outer parallel surfaces to any dimension within a given range by sliding one block on the other.

PLANETARY ACTION:
A double mechanical motion in which a tool is rotated on a center, while that center is revolved in another circle at the same time.

PLATE PRESS:
A filter press that removes water from gluten.

PLISSE:
Crepe fabric which is formed by printing caustic soda on cotton cloth. The printed areas shrink causing unprinted areas to blister, forming raised design. Widely used for garments, such as nightwear.

PLUG:
Rubber block marked to indicate hat size.

PLUGBOARD:
See PATCHBOARD.

PNEUMATIC CONVEYOR:
A system with pumps or blowers arranged to draw or force material by air through pipes, ducts, or hoses from one area to another. Also known as AIRVEYOR when material or small articles are blown by compressed air.

POACHING:
Process of removing acid and impurities from nitrocotton prior to processing into explosives.

POINTS:
One of a set of parallel slender rods fitted into slotted metal bar used in knitting to form or position stitches or loops.

POISE:
In a scale, a weighbeam element movable parallel to the longitudinal axis of the weighbeam, whose position with reference to graduations on the weighbeam or with reference to a fixed index, constitutes the weight indication.

POISE; POISING:
Equal distribution of mass of timepiece balance wheel around axis of rotation that neutralizes effect of gravity. POISING is accomplished by removing or adding weight to balance wheel to create equal distribution of mass around axis.

PONTIC:
The suspended tooth of a fixed partial denture that replaces lost natural tooth.

PORCUPINE:
A studded, iron ball suspended from cable on electrically controlled drum on the larry.

POTENTIAL DIFFERENCE:
A difference in electrical states existing at two points, which causes current to tend to flow between them. It is measured by work done in transferring a unit charge of electricity from one point to the other.

POTEYE:
A ring-shaped device through which open cloth is drawn to bunch it longitudinally into ROPE FORM.

POUNCE I:
To transfer a design through perforated paper stencil by rubbing or striking perforations with bag of powder or charcoal.

POUNCE II:
To smooth surface of felt hat with sandpaper.

POUND NET:
An enclosed mesh trap with a funnel-like opening, set up at the end of other diversion-type nets to catch and hold fish.

POWER PRESS:
A machine, used in conjunction with dies, for forming, molding, cutting, and shaping of materials under great pressure.

PREFORM RUBBER:
Uncured rubber that is precut to provide specific amount of rubber necessary to fill each mold cavity.

PRICKLER ROLL:
A large metal roll with sharp protruding pins that puncture rubber-covered belt to remove trapped air.

PRIMACORD:
A flexible woven cord with an explosive core which detonates at an extremely fast velocity of over 20,000 feet per second.

PRINTED CIRCUIT BOARD:
A conductive pattern reproduced on insulator (usually laminated plastic) used in place of wires in electronic equipment.

PRINTING ROLLER:
See PRINTING SHELL.

PRINTING SHELL:
A large, engraved copper roller used to print designs in color on cloth when mounted in printing machine.

PROFILAMETER:
An instrument for measuring roughness or smoothness of surface finish of machined parts.

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226

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PROGRAM MACHINE:
A testing device equipped with clocks and mechanism which feeds perforated tape through machine on 24-hour cycles. Perforations permit electrical contacts which open and close relays to discharge cells at prescribed intervals.

PROGRESSIVE DIE:
An integrated stamping die made up of several die units or stations through which workpiece is indexed one station at a time for a series of operations. Usually, a continuous strip of sheet metal is fed into press and completely formed workpiece is ejected from other end with each action of press.

PROJECTION (SHADOW) COMPARATOR MACHINE:
Floor-mounted machine that employs intense light to project shadow of machined workpiece onto master drawing which is laid on a lighted table screen. The shadow is alined with the master drawing to determine conformance of workpiece to specifications.

PRONGS:
Scissorslike tool with three tines, one on one handle and two on other, used for gripping and twisting.

PROOF BOX:
A cabinet conditioned by steam to maintain constant humidity and temperature of about 80 degrees Fahrenheit. Leavened dough is enclosed in box to accelerate fermentation of yeast. Also known as dough closet.

PROVER:
A device for passing measured amount of gas or compressed air under constant pressure through gasmeters to test accuracy of meters.

PSEUDO INSTRUCTION I:
A symbolic representation in a compiler or interpreter.

PSEUDO INSTRUCTION II:
A group of CHARACTERS having the same general form as a computer INSTRUCTION but never executed by the computer as an actual INSTRUCTION.

PUGMILL:
A machine which mixes plastic clay and delivers it in homogeneous, compact form suitable for making pottery and brick. Frequently mill is equipped with vacuum chamber to remove air from clay.

PULL-TEST MACHINE:
A testing device in which pounds of pull, necessary to pull bullet out of cartridge case, are measured.

PULSATION RECORDER:
An instrument equipped with a revolving drum and a pressure-sensitive pen which marks the duration and intensity of vacuum-cycle waveforms when its probe is inserted into a vacuum line. It is used to test the operation of automatic milking systems.

PUTTING-IN-BEAT:
See IN-BEAT.

QUARTERS:
The parts of the upper of a shoe that extend from vamp to back.

QUILL:
See FILLING BOBBIN.

QUILLER:
A machine that separates strands of yarn in warp and winds each strand on bobbin or QUILL.

RACK I:
The standard unit of measure for lace. It is the amount of lace woven by 1,920 single motions of loom.

RACK II:
An element of the indicating mechanism, usually mounted vertically, consisting of a straight bar with teeth on one face designed to mesh with those of a pinion, and so attached to lever train that its vertical motion is proportional to the change in applied load.

RADIAL DRILL PRESS:
A machine tool used primarily for metal drilling, which consists of central column and horizontal radial arm to which a vertical drilling spindle is attached.

RADIO FIX:
Straight-line radio signal or signals on which receiving station takes bearings to determine geographical position. RADIO FIX is used in both marine and air navigation.

RANGE:
An arrangement of machines used to perform a number of yarn- or cloth-processing operations continuously by feeding material to each unit in succession automatically and without interruption.

RAPPING:
The process of removing ore dust that has accumulated on wires in the stack treater to recover the ore.

RASCHEL FABRIC:
A fabric produced on raschel-knitting machines which may vary from the sheerest tulle to coarse carpeting, including specialties, such as lace and elastic fabrics.

READ:
To copy information from one form of STORAGE to another or to SENSE the meaning of stored information.

READY-ROOM:
A room set aside near airplane loading area where crew members assemble for station assignments and briefing sessions.

RECLAIM:
Rubber material recovered from scrap rubber goods by chemical treatment.

REED:
One of a number of thin, flat pieces of steel wire between which warp threads are drawn after they pass through the harness of a loom. They push the FILLING against the FELL of the cloth.

REED HOOK:
A flat metal tool, similar to crochet hook, used for drawing individual strands of yarn through REED of loom.

REEDING:
Nylon monofilament or copper wire used to reinforce and shape sweatbands and brims on hats and caps.

REEF NET:
A bag-like net anchored to boats or shore to simulate V-shaped reef in channel.

REEFER:
The refrigerated compartment on a ship in which perishable food is stowed.

REFLECTANCE METER:
A small, bench-mounted device used to compare the whiteness of bleached paper pulp to a standard white color.

REFRACTOMETER:
An optical instrument that measures index of refraction of a liquid, from which percentage of sugar, alcohol, salt, or other substances can be determined by comparison with a chart.

REGAGING:
Process of verifying alcoholic content of recently distilled liquor to determine quantity of diluent necessary to be added to liquor to obtain specified alcoholic content.

REGISTER:
Correct relative position of two or more colors when printed from color plates.

REGISTER WHEEL:
A large indexed wheel on pantograph or engraving machine. A gross setting on larger register wheel results in precise placement of design on smaller printing roller.

REGULATOR:
Movable pointer or lever in timepiece used to adjust rate of timepiece movement by lengthening or shortening active length of hairspring. One end of regulator moves over graduated scale as other end adjusts position of regulator pins between which overcoil of hairspring vibrates.

RELIEVING:
A machining process in which a FORM TOOL is used to cut teeth for cutting tools to specified contour.

REST-BEER:
Beer left in tanks which is drawn off, mixed with other beer, and filtered.

RETAINER:
That part of a fixed or removable partial denture which unites abutment tooth with suspended portion of denture.

RIBBON:
Thin metal strip or band used for transmitting force, as from the lever system to the cam of a pendulum assembly. Sometimes called a tape.

RIBS:
Raised metal surfaces extending length of shotgun barrel to provide glare-proof sighting surface when aiming. See SIGHTING RIB.

RIFT:
The direction of the plane of fracture in stone along which it can be split most easily.

RING-ROLLING MACHINE:
A machine with one or more pairs of arms which revolve away from each other, catch latex at point of dipping, and roll it up the neck forming the ring of balloon.

227

ROD TRANSFER DEVICE:
A metal box-shaped device approximately eight inches tall, three inches wide, and three inches deep that is open on one side with a rectangular slot on the end. There is a swivel eye on the other end of the device where a rod hoist cable is attacheu. The rectangular opening at the lower end of the device is fitted on square neck of rod to support rod sections as they are being transferred to and from holding slots and lifting clamp.

ROLL PICKER:
A pneumatic tool which removes lint and trash from spinning and roving frames by winding it on rapidly rotating spindle.

ROLLER:
Circular metal plate that transmits impulses from pallet to balance wheel in a timepiece. Transmission is accomplished by means of roller jewel that rides into and out of fork of pallet. There are usually two rollers, the smaller of which is called a safety roller which acts to prevent pallet from releasing *escape wheel* when roller jewel is out of pallet fork.

ROLLING TABLE:
A heated press, the upper platen of which lowers and pivots on a shaft, to compress and roll resin impregnated fabrics onto mandrel.

ROPE FORM:
The form in which cloth is gathered or bunched into longitudinal folds by being drawn through a ring or series of rings. Some processing is more easily accomplished with cloth in this form.

ROPING:
See ROVING.

ROTARY LATHE:
A machine for cutting thin sheets of veneer from logs. The log is supported and rotated on horizontal axis as heavy steel knife is fed against its surface to slice thin sheet of wood from circumference.

ROUNDING JACK.
A handtool for trimming hat brims. One end of tool is fitted with sharp blade and the other end is shaped to rest on crown of hat. The tool is drawn around hat brim, using crown as guide, to cut off excess material.

ROUTINE:
A set of coded INSTRUCTIONS arranged in proper sequence to direct the computer to perform a desired operation or sequence of operations. A subdivision of a program consisting of two or more INSTRUCTIONS that are functionally related; therefore, a program.

ROVING:
A continuous, soft, slightly twisted strand of fibers. It is the product of a roving frame, is made from sliver, and is used to produce yarn.

RUN:
The performance of one program on a computer, thus the performance of one ROUTINE or several ROUTINES linked so that they form an automatic operating unit, during which manual manipulations by the computer operator are zero or at least minimal.

SAFETY ROLLER:
See ROLLER.

SASH GANGSAW:
A series of heavy saw blades set in metal frame that reciprocates vertically, used to cut several boards simultaneously from log or cant.

SCINTILLATION AND POSITRON SCANNERS:
Instruments for measuring physical properties of radium.

SCRATCHING TOOL:
A four-pronged, long handled tool similar to a pitch fork and used to pull up loops and uncut ends of rug pile.

SCRAY:
A container or rack used to collect sheet material, such as cloth, in folds or pleats for drying or inspection; or to allow for accumulation of goods between machines operating at different speeds to process material in a continuous operation. It also allows additional cloth to be sewed on without stopping machine.

SCREED:
A wooden or metal strip, cut to coincide with proposed sectional contour of roadway, used to level fresh concrete or asphalt.

SCREEN:
A sheet of glass ruled in fine lines, used in the reproduction of halftones. The screen is inserted in the camera, and divides the photograph into a gridiron of squares or dots. The density of shade or tone of any portion of the halftone is determined by the number of dots per unit area that exist on the halftone.

SEAM:
A finished edge on flat glass or mirrors on which the sharp corners are removed by an abrasive belt to form a semi-rounded edge.

SEAMED EDGE:
See SEAM.

SEARCHER:
A notched metal strip, tooled to 0.0005 inch thickness, used to remove small particles of threads from brass bobbins.

SEED:
Crystallized sugar added to supersaturated corn-sugar solution to hasten formation of corn-sugar crystals.

SELCALL:
Radio equipment that allows flight crew to communicate with another aircraft in flight without such call interfering in radio communications of other nearby but unconcerned aircraft.

SENSE:
To READ the holes punched in a card or tape.

SERGE:
To machine sew a v-shaped stitch over the edge of a single ply of material to prevent edge fraying.

SET POINT:
A point in space, expressed in three dimensional coordinates, at which tip of cutting tool of automatic machine is set before the start of machining operations.

SHADOW LINES:
Lines on power ripsaw machine table cast by wire hung between light source and table. Used as guides by saw operators in alining boards before they enter the saw.

SHAKE:
A shingle split from a piece of log usually three or four feet long.

SHED:
The opening in warp threads through which FILLING passes.

SHEDDING MOTION:
The first of three basic motions involved in weaving yarn into cloth. The motion resulting from mechanism of loom that operates harness to separate warp threads and form SHED for passage of shuttle.

SHEET PILING:
Long narrow strips of heavy sheet metal that are interlocked and driven into the earth to serve as retaining wall for earth or water during excavation. Also known as SHEETING.

SHEET-PILING DRIVER:
A compressed-air or gasoline-powered hammer used to drive sheet piling. It has a U-shaped shoe or striking head that fits over end of pile.

SHEETING:
See SHEET PILING.

SHELF-LIFE:
A term used to denote measurement of life of products in storage or shipment. It is used in connection with beverages (beer) and dry-cell batteries, indicating degree of capacity or usability when put to use.

SHERIFF'S SALE:
A public sale of properties lawfully seized by county as directed by civil court order; money received reverts to county treasury.

SHIMS:
Strips of metal, flat on one side and curved on the other, used in pairs with wedge between to split stone. May also be known as FEATHERS.

SHOOT WIRE:
Wires running short way of cloth or screen as woven.

SHOPPING SERVICE:
A service paid for by a store and conducted by an outside organization to test, through actual shopping, courtesy, integrity, honesty, and selling ability of establishment's sales and service personnel.

SHORT-CYCLE SEWING MACHINE:
A semi-automatic machine which sews a limited number of stitches to tack layers of fabric, attach buttons, or make buttonholes.

SHOT PAN:
A pan, resembling frying pan, with equidistantly spaced holes in bottom through which molten lead is dropped to form shot pellets. Pans are numbered according to size of holes.

SHUTTLE BINDER:
A wood or iron lever located at front or back of, and projecting slightly into, the SHUTTLE BOX. Its purpose is to check force of shuttle as it enters the box.

SHUTTLE BOX:
The container at each side of a loom that receives shuttle at the end of its passage.

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SIEVE CLOTH:
The fabric belts on printing machine which absorb color solutions from color trays and convey it to rollers that print designs on wallpaper.

SIGHTING RIB:
Raised metal rib along entire outside length of shotgun barrel which is matted (knurled) to provide a glare-proof sighting surface.

SINKER I:
An elevator platform that submerges felt hat cones in tub of hot water to strengthen cohesion of fur fibers.

SINKER II:
Slender rods in slotted metal bar used in knitting machines to depress loops upon or between needles.

SIPES:
Metal strips inserted in grooves of tire molds to impart thread design in cured tires.

SKIRTING UPPER:
The sewn-together vamp, quarters, and counter of nonrubber upper of an article of footwear before rubber, composition, or cork sole is put on. The bottom edges of upper are cemented all around, like the hem of a skirt, for bonding with sole.

SLAKED LIME:
A chemical combination of calcium, hydrogen, and oxygen formed by combining quicklime and water.

SLIDE:
In a timepiece the distance PALLET STONE moves downward on ESCAPE WHEEL tooth after locking.

SLUBBER:
The first fly frame for drawing and twisting slivers to form ROVING.

SOFT BOARD:
See BOARD.

SPACE GAGE:
A rectangular metal piece with parallel rows of fine grooves extending across its face, used as a guide for spacing needles in the NEEDLE BAR of a knitting machine.

SPEECH READING:
Visual interpretation of speech, from lip movements, facial expressions, and body movements. Also known as lip reading.

SPINNING BOX:
A device used in rayon manufacturing for piling thread into ring-shaped CAKES. The thread is drawn into spinning box through glass funnel and wound by centrifugal force.

SPOIL PILES:
Earth and rock removed from coal, ore, or rock deposit in strip mine, open pit, or quarry.

SPONGE:
A powder form of cadmium with a high zinc content.

SPOT-FACING:
A machining process in which the area around a hole is milled to smooth, flat surface by application of a rotating tool with cutting edges on its end or face.

SPREADER PAN:
A pan, resembling a frying pan, with holes around the side which sets on legs in the SHOT PAN and spreads lead evenly around shot pan.

SPRUNG OIL:
Oil that has been allowed to separate from water and rise to the surface by means of gravity.

SPUR CHUCK:
A stubby, pronged fork attached to driving spindle of lathe to assist in mounting and centering workpieces.

SPUTTERING:
Bombarding metal surface with positive ions to form fine-grained coating on surface.

SQUEEGEE:
A strip of uncured rubber, approximately tread-width, which is applied to BAND stock to reduce friction and promote adhesion between plies of completed tire.

STAB:
A small metal point set in a die used to mark material which is to be sewn.

STAB SETTER:
A tool shaped like a hand punch that fits over the STAB. A hammer is used to set STAB in die.

STABILITY GAGE:
An instrument equipped with needle gage used to indicate variation in or inadequacy of vacuum in automatic milking systems.

STAKING:
Technique of forcing timepiece parts friction tight into holes or onto shafts by pressing or riveting, using hand staking tool or staking machine.

STAMPER:
Negative electroplate made by electrodeposition on MOTHER electroplate. Stampers are used in record presses to press positive of recording into phonograph records.

STANDARD SIZE SYSTEM:
A system decreed by Edward II in 1324 that established a variation of one-sixth of an inch in length between half sizes and one-third of an inch in length between whole sizes of shoes.

STARTER:
A bacteria used for souring milk or cream in making dairy products, or for promoting fermentation.

STEAM LANCE:
A long pipe attached to a steam source, through which steam under pressure is blown into boiler tubes to remove soot and sludge.

STENO-MASK:
An enclosed microphone, used to record speech on tape, which renders the spoken word inaudible to other persons in the room.

STICKERS:
Pieces of lumber used to provide space for warm air between layers of green lumber, to promote drying.

STIPPLING TOOL:
A small block of metal, the under surface of which is covered with small projections. It is used to make multiple indentations in wood by striking top of tool with hammer or mallet.

STIRRUP:
A shackle which transmits to a connection load from only one lever.

STITCH-BONDING:
A process whereby barbed needles are used to bond or entangle web fibers to produce a nonwoven fabric.

STITCHING WHEEL:
A wheel mounted in the bed of an ULTRASONIC SEAMING MACHINE. WHEEL has raised pattern that simulates sewing machine stitches. Wheels are changed to produce various decorative effects.

STONE LAY:
A scheme or diagram of type pages as they should be imposed on the stone or table as opposed to how they actually appear on the printed sheet.

STORAGE:
Pertaining to a computer component into which data can be entered, in which they can be held, and from which they can be retrieved at a later time. Synonymous with MEMORY.

STRAPPING TOOL:
A hand-operated device that pulls taut strip-steel straps wrapped around a bale and secures ends by pinching a cleat placed around overlapping ends of strap.

STRIKE:
A batch of sugar liquor drained from vacuum pans after boiling has created sugar crystals and reduced solution to specified consistency.

STRIKE UP MARKS:
Light pencil lines drawn across and at right angles to the junction of two sail cloths and used as guides to sew cloths together.

STRINGING:
Sewing pairs of tobacco leaves to a length of cord by means of an automatic machine that pierces stems of leaves with needle.

STUFFING BOX:
A small cylindrical box, filled with fibrous material, mounted on the frame of a machine surrounding a piston rod. Its purpose is to make an airtight or steamtight joint.

STUMMEL:
The portion of a smoking pipe consisting of the bowl and shank.

SUBROUTINE I:
The set of INSTRUCTIONS necessary to direct the computer to carry out a well-defined mathematical or logical operation.

SUBROUTINE II:
A subunit of a ROUTINE. A SUBROUTINE is often written in relative or symbolic coding even when the ROUTINE to which it belongs is not.

SUBROUTINE III:
A portion of a ROUTINE that causes a computer to carry out a well-defined mathematical or logical operation.

229
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SUBROUTINE IV:
A ROUTINE which is arranged so that control may be transferred to it from a master ROUTINE and so that, at the conclusion of the SUBROUTINE, control reverts to the master ROUTINE. Such a SUBROUTINE is usually called a closed ROUTINE.

SUBROUTINE V:
A single ROUTINE may simultaneously be both a SUBROUTINE with respect to another ROUTINE and a master ROUTINE with respect to a third. Usually control is transferred to a single SUBROUTINE from more than one place in the master ROUTINE and the reason for using the SUBROUTINE is to avoid having to repeat the same sequence of INSTRUCTIONS in different places in the master ROUTINE.

SUCTION DREDGE:
A floating dredging machine that excavates by means of a centrifugal pump and suction tube that draws mud or saturated sand from a channel and discharges it on shore or elsewhere.

SUPER:
A section or story of a beehive containing 8 or 10 frames suspended inside on which bees build honeycomb and fill it with honey.

SURFACE GAGE:
A device for measuring and marking metal parts at precise distances above a plane surface. It consists of a flat-surfaced metal block and a pointed adjustable rod of hardened steel mounted on the block.

SURVEYOR:
A precision instrument used to make a pencil mark around a tooth indicating its greatest circumference in any one position relative to the vertical.

SWEEPS:
A curved piece of plastic or metal that represents a segment of a circle of a known radius. It is used to check accuracy of curves or to draw original curves.

SWING WEIGHT:
The swing weight of a golf club is a measure of the leverage of the club, from beyond a fixed point, applied against the end of the handle. It is the weight felt by the golfer when he swings the club.

SWING-FOLDING ATTACHMENT:
A device, usually attached to the rear of a processing machine, to fold cloth coming from the machine. It consists of a pair of thin parallel rollers mounted between two arms that swing like a pendulum, laying cloth in loose folds.

TACK:
Riding equipment, such as saddle, riding crop, and saddle weights, used by jockey to ride race horse.

TAKEUP ROLL:
A roller, operating continuously or intermittently, that winds long lengths of material after it has passed through a machine.

TALKING BOOK:
An album of phonograph records containing complete text of book, periodical, or series of articles, for use by blind library patrons.

TANK DOME:
Term applied to insulated domes that cover the top of missile sections (tanks).

TAPE CONDENSER:
A device that removes web (a sheet of cotton or other fibers) from CARDING MACHINE, divides, and condenses it into ROPING ready for spinning.

TARGET BLOCK:
A tungsten block, having the same thickness as a workpiece to be welded by electron-beam system, used to substitute for workpiece during system setup.

TELESCOPING GAGE:
A precision measuring instrument the end of which can be positioned inside hole or opening and expanded to touch walls; interior dimension can then either be read on calibrations of gage or measured with micrometer.

TELETICKETER:
An electrical device that transmits and prints transportation-routing information on passenger tickets.

TEMPERATURE POTENTIOMETER:
A device to take temperature readings at any given point via transmission through thermocouples to reading device. It is equipped with dial to select from which thermocouple (point) to take reading.

TENSION GUIDE:
A device used as guide to provide specified tension during winding, coning, sizing, and warping. This device contains fingers, disks, or washers that apply tension.

TENTER FRAME:
A machine that dries and stretches cloth to its original width and straightens its weave after a finishing process.

THATCHER:
A machine (similar to a rotary-type lawn mower with wire claws, rather than blades, on the rotating bar) used to claw and lift thatch from lawn.

THREADER:
A long, large needle or a metal plate equipped with wire hooks used in threading yarn through needles of knitting machine.

THRUST END ASSEMBLY:
The forward end of turbine at which steam enters.

TIDAL PEN:
Large rectangular ponds constructed on island located in natural shrimp growing area with screened gates at ends to allow pens to be flushed by tidal flow. Gates can be raised for impoundment of shrimp larvae and shrimp scavners.

TIMER DRUM:
A metal drum containing series of paralleled slots extending around its circumference to hold timing buttons that trip solenoid switches, as drum revolves, to control operation of bottlemaking machine.

TITRATION:
The method or process of determining the strength of a solution in terms of the smallest amount which will bring about a given reaction with another known substance. Usually the test is accomplished by the use of an indicator (such as litmus) which changes in color when the reaction takes place.

TOE BOARD:
The portion of a board on which toe of stocking is shaped.

TOP:
An untwisted strand for sliver of long wool or synthetic fibers from which short fibers have been combed. Top is wound into ball form (about 5 to 15 pounds) after combing.

TORQUE CHUCK:
A chuck equipped with clutch that slips when under a given tension.

TOW:
A large number of continuous synthetic filaments bunched in loose ropelike form with very little twist.

TRACER CONTROL:
A system of machine-tool control in which the cutting tool is automatically made to move in precise parallel relationship to a stylus that is held against and moved along edge of a flat template or surface of three-dimensional model. The motion may be mediated mechanically, hydraulically, or electrically, or by a combination of these.

TRACER POINT:
A metal rod placed in chuck of master spindle of wood-carving machine, used to follow around the contour of carving pattern.

TRANSCEIVER:
A combination of radio transmitting and receiving equipment with some electronic units being used for both transmitting and receiving.

TRANSFER BAR:
A rectangular metal bar used to transfer knitted garment parts from one full-fashioned knitting machine onto NEEDLE BAR of another.

TRANSFER PAPER:
Paper on which design or information, such as size, style, brand names, and yarn content has been printed with special ink that transfers information or design to article when paper is pressed against article with heated iron.

TRANSFER POINT:
The needlelike projections on a TRANSFER BAR or TRANSFER RING over which stitches of knitted material are hung when the material is transferred from one machine to another.

TRANSFER RING:
A circular metal ring, equipped with vertical needle points, used to transfer knitted material from one machine to another.

TRANSPONDER:
A radio device which identifies other aircraft in flight by deciphering code signals relayed from ground stations.

TRAVELER:
A small free-running metal ring sliding on a bar through which yarn passes to impart a twist to the yarn.

TRIBOX:
Glass enclosed container housing thermometer and hydrometer through which distilled liquor flows, allowing temperature and specific gravity proof of liquor to be measured.

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TRIP BUTTONS:
Small bolts locked in slots on TIMER DRUMS to trip solenoid switches that start and stop functions of bottlemaking machines.

TRUING 1:
The shaping of grinding wheel for purpose of producing consistent flatness or contour on the ground workpiece. Usually accomplished by application of diamond, abrasive, or hard-metal tool.

TRUING 2:
Technique used for correcting errors in timepiece balance wheels and hairsprings. Balance wheel truing is accomplished by bending the wheel rim until it lies in a single plane and is concentric with and perpendicular to the staff axis. Hairspring errors are either in the round (coils are not perfectly concentric with collet) or in the flat (coils are not in same plane as collet). Hairsprings are trued by bending coil to correct faulty colleting.

TRUSS HOOP:
A thick iron hoop used to temporarily hold together barrel staves.

TUBE I:
A hollow cylinder of cardboard on which cloth or yarn is wound for shipment.

TUBE II:
A common term used in the paper goods industry to indicate that portion of a paper bag without a bottom.

TUNNEL HEADING:
That part of tunnel where digging operations are performed.

TURNER TUBES:
A device used in turning gloves, with corresponding rods that push the finger tips of the glove into the tube, partially turning it. Turning is completed manually by worker or automatically on machine.

TURNINGS:
An article that has been cut to cylindrical shape on lathe.

ULTRASONIC HORN:
A resonant bar or metal section which transfers energy from converter to workpiece.

ULTRASONIC SEAMING MACHINE:
A machine that uses high-frequency sound waves to fuse layers of thermoplastic material simulating a stitchline. The machine resembles a sewing machine in appearance and operation but uses no thread and has a HORN and STITCHING WHEEL for impressing a stitch pattern. The stitching wheel can be changed to produce various decorative effects.

ULTRASONIC WAVE MACHINE:
A machine that removes foreign matter from polished lenses by sound waves.

UNISHANK:
A method of shoe construction in which the insole, steel shank, and tuck are incorporated into a single unit.

V-RING:
Rings that are assembled to each end of the commutator, pressed together, and bolted or screwed to the hub of the armature to keep the copper bars in alinement.

VAMP PLUG:
On moccasin-toed shoes, a separate piece of material fitted into the upper from the toe over the instep.

VENEER BLOCK:
A log cut to length for peeling or slicing into veneer.

VERIFIER:
A device that automatically compares (verifies) the CHARACTERS on a manual transcription against retranscription.

VIBRATING:
Process of determining that length of timepiece hairspring will cause balance wheel to vibrate a fixed number of times per hour. Factors considered are length, width, thickness, and strength of hairspring.

WARP:
Any thread or yarn that runs lengthwise in material woven on a loom.

WARP WIRE:
Wires running the long way of the cloth or screen as woven.

WEAVER'S KNOT:
A small flat knot that is used to join ends of yarn.

WEB:
Excess metal which has been forced into holes at the parting line of dies during a forging operation.

WEBBING STRETCHER:
A handtool used to stretch webbing across furniture seat frames.

WELT:
A closely knit, usually double fabric, part of a woman's stocking, at the upper portion of the stocking, that resists wear.

WELT BAR:
A bar of a knitting machine containing a row of small steel hooks (welt points) that hold the first loops or stitch of fabric until the welt is knitted.

WELT ROD:
A small metal rod used to facilitate turning of welt on full-fashioned stockings and to wind hose on takeup roller.

WHIPSTOCK:
A device that is installed at the point of an obstruction in well hole and used to drill around lodged or broken drill bits, lost tools, or other obstacles to facilitate their removal or recovery from boreholes of oil or gas wells.

WHIRLING MACHINE:
Machine that distributes photosensitive solution over surface of photographic printing plates by means of a rotating or whirling action.

WHITE WATER:
Water separated from paper pulp during processing. It contains varying amounts of reclaimable fibers, fillers, dyestuffs, and other elements.

WHITING COMPOUND:
A mixture of powdered chalk and liquid glue used to form wood sealer or priming base for further application of paint.

WICK:
Strands of asbestos twisted together and used for making asbestos rope, packing for steam valves, and as a seal for oven or furnace doors.

WINDUP RACK:
A rack that has a continuous drive action which winds long lengths of material into a roll after material has passed through a machine.

WORD:
An ordered set of CHARACTERS which occupies one STORAGE location and is treated by the computer circuits as a unit and transferred as such. Ordinarily a WORD is treated by the control unit as an INSTRUCTION and by the arithmetic unit as a quantity. WORD lengths may be fixed or variable, depending on the particular computer.

WORD PROCESSING:
Office-equipment systems used to facilitate recording and processing of correspondence, records, and related texts by means of such components as PAPER-TAPE, MAGNETIC-TAPE, or magnetic-card terminals (typewriter keyboards which transmit data into computers).

WORM:
A power-driven cutting bead, rotating in such a manner that it moves forward through a pipe, cutting scale, chemical deposits, and other residue from the wall of the pipe.

YARN CARRIER:
In flat knitting, the sliding frame above the needlebeds that hold the cams and yarn guides and carries them to and fro.

Z-CALENDER:
See FOUR-ROLL CALENDER.

ZIGZAG SEWING MACHINE:
A machine that sews with an oscillating needle. The pattern of the stitches can be varied by changing cams. Used where a decorative, stretchable stitch is needed.

ZYGLO:
Trade name for a penetrating fluorescent solution used to detect defects at or near the surface of non-magnetic ferrous metals.

DIVISION OF PROGRAM DEVELOPMENT
OFFICE OF VOCATIONAL EDUCATION
GEORGIA DEPARTMENT OF EDUCATION
ATLANTA, GEORGIA 30334
CHARLES McDANIEL, STATE SUPERINTENDENT OF SCHOOLS
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Title VI - Peyton Williams Jr., Associate Superintendent of State Schools and Special Services
Title IX - Myra Tolbert, Coordinator
Section 504 - Jane Lee, Coordinator of Special Education

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